FINANCIAL ASSISTANCE
FUNDING OPPORTUNITY ANNOUNCEMENT

ADVANCED RESEARCH PROJECTS AGENCY – ENERGY (ARPA-E)
U.S. DEPARTMENT OF ENERGY

CATALYZING INNOVATIVE RESEARCH FOR CIRCULAR USE OF LONG-LIVED ADVANCED RECHARGEABLES SBIR/STTR (CIRCULAR SBIR/STTR)

Announcement Type: Initial Announcement
Funding Opportunity No. DE-FOA-0003324
CFDA Number 81.135

Funding Opportunity Announcement (FOA) Issue Date:	January 31, 2024
First Deadline for Questions to ARPA-E-CO@hq.doe.gov:	5 PM ET, March 1, 2024
Submission Deadline for Concept Papers:	9:30 AM ET, March 12, 2024
Second Deadline for Questions to ARPA-E-CO@hq.doe.gov:	5 PM ET, TBD
Submission Deadline for Full Applications:	9:30 AM ET, TBD
Submission Deadline for Replies to Reviewer Comments:	5 PM ET, TBD
Expected Date for Selection Notifications:	September 2024
Total Amount to Be Awarded	Approximately $30 million, subject to the availability of appropriated funds.
Anticipated Awards	ARPA-E may issue one, multiple, or no awards under this FOA. The Federal share of awards may vary between $500,000 and $5 million.

- For eligibility criteria, see Section III.A – III.D of the FOA.
- For cost share requirements under this FOA, see Section III.E of the FOA.
- To apply to this FOA, Applicants must register with and submit application materials through ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/Registration.aspx). For detailed guidance on using ARPA-E eXCHANGE, see Section IV.H.1 of the FOA.
- Applicants are responsible for meeting each submission deadline. Applicants are strongly encouraged to submit their applications at least 48 hours in advance of the submission deadline.
- For detailed guidance on compliance and responsiveness criteria, see Sections III.F.1 through III.F.4 of the FOA.

Questions about this FOA? Check the Frequently Asked Questions available at http://arpa-e.energy.gov/faq. For questions that have not already been answered, email ARPA-E-CO@hq.doe.gov (with FOA name and number in subject line); see FOA Sec. VII.A. Problems with ARPA-E eXCHANGE? Email ExchangeHelp@hq.doe.gov (with FOA name and number in subject line).

TABLE OF CONTENTS

REQUIRED DOCUMENTS CHECKLIST ..... - 1 -

I. FUNDING OPPORTUNITY DESCRIPTION ..... - 2 -

A. AGENCY OVERVIEW ..... - 2 -
B. SBIR/STTR PROGRAM OVERVIEW ..... - 3 -
C. PROGRAM OVERVIEW ..... - 4 -
D. PROGRAM OBJECTIVES ..... - 11 -
E. TECHNICAL CATEGORIES OF INTEREST ..... - 13 -
F. TECHNICAL PERFORMANCE TARGETS ..... - 15 -

II. AWARD INFORMATION ..... - 20 -

A. AWARD OVERVIEW ..... - 20 -
B. RENEWAL AWARDS ..... - 20 -
C. ARPA-E FUNDING AGREEMENTS ..... - 21 -
D. STATEMENT OF SUBSTANTIAL INVOLVEMENT ..... - 21 -

III. ELIGIBILITY INFORMATION ..... - 23 -

A. ELIGIBLE APPLICANTS ..... - 23 -
1. SBIR ELIGIBILITY ..... - 23 -
2. STTR ELIGIBILITY ..... - 23 -
3. JOINT SBIR AND STTR ELIGIBILITY ..... - 24 -
B. ELIGIBLE SUBRECIPIENTS ..... - 24 -
1. RESEARCH INSTITUTIONS ..... - 24 -
2. OTHER PROJECT TEAM MEMBERS ..... - 24 -
C. ELIGIBLE PRINCIPAL INVESTIGATORS ..... - 25 -
1. SBIR ..... - 25 -
2. STTR ..... - 25 -
D. ELIGIBILITY OF PRIOR SBIR AND STTR AWARDEES: SBA BENCHMARKS ON PROGRESS TOWARDS COMMERCIALIZATION ..... - 26 -
E. COST SHARING ..... - 27 -
F. OTHER ..... - 27 -
1. COMPLIANT CRITERIA ..... - 27 -
2. RESPONSIVENESS CRITERIA ..... - 28 -
3. SUBMISSIONS SPECIFICALLY NOT OF INTEREST ..... - 29 -
4. LIMITATION ON NUMBER OF SUBMISSIONS ..... - 30 -

IV. APPLICATION AND SUBMISSION INFORMATION ..... - 31 -

A. APPLICATION PROCESS OVERVIEW ..... - 31 -
1. REGISTRATION IN SBA COMPANY REGISTRY ..... - 31 -
2. REGISTRATION IN ARPA-E eXCHANGE ..... - 31 -
3. CONCEPT PAPERS ..... - 31 -
4. FULL APPLICATIONS ..... - 32 -
5. REPLY TO REVIEWER COMMENTS ..... - 32 -

6. *Pre-Selection Clarifications and "Down-Select" Process* ..... - 32 -
7. *Selection for Award Negotiations* ..... - 33 -
B. Application Forms ..... - 33 -
C. Content and Form of Concept Papers ..... - 33 -
1. *Concept Paper* ..... - 34 -
A. *Concept Summary* ..... - 34 -
B. *Innovation and Impact* ..... - 34 -
C. *Proposed Work* ..... - 34 -
D. *Team Organization and Capabilities* ..... - 35 -
D. Content and Form of Full Applications ..... - 35 -
E. Content and Form of Replies to Reviewer Comments ..... - 35 -
F. Intergovernmental Review ..... - 35 -
G. Funding Restrictions ..... - 35 -
1. *Allowable Costs* ..... - 35 -
2. *Pre-Award Costs* ..... - 36 -
3. *Patent Costs* ..... - 36 -
4. *Construction* ..... - 36 -
5. *Foreign Travel* ..... - 36 -
6. *Performance of Work in the United States* ..... - 36 -
7. *Purchase of New Equipment* ..... - 37 -
8. *Technology Transfer and Outreach* ..... - 37 -
9. *Lobbying* ..... - 38 -
10. *Conference Spending* ..... - 39 -
11. *Independent Research and Development Costs* ..... - 39 -
12. *Prohibition on Certain Telecommunications and Video Surveillance Services or Equipment* ..... - 40 -
13. *Buy America Requirement for Public Infrastructure Projects* ..... - 40 -
14. *Requirement for Financial Personnel* ..... - 40 -
H. Other Submission Requirements ..... - 41 -
1. *Use of ARPA-E eXCHANGE* ..... - 41 -

V. APPLICATION REVIEW INFORMATION ..... - 43 -

A. Criteria ..... - 43 -
1. *Criteria for Concept Papers* ..... - 43 -
2. *Criteria for Full Applications* ..... - 44 -
3. *Criteria for Replies to Reviewer Comments* ..... - 44 -
B. Review and Selection Process ..... - 44 -
1. *Program Policy Factors* ..... - 44 -
2. *ARPA-E Reviewers* ..... - 45 -
3. *ARPA-E Support Contractors* ..... - 45 -
C. Anticipated Announcement and Award Dates ..... - 46 -

VI. AWARD ADMINISTRATION INFORMATION ..... - 47 -

A. Award Notices ..... - 47 -
1. *Rejected Submissions* ..... - 47 -
2. *Concept Paper Notifications* ..... - 47 -
3. *Full Application Notifications* ..... - 47 -

B. ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS ..... - 47 -
1. UNIQUE ENTITY IDENTIFIER- AND SAM, FSRS, AND FEDCONNECT REGISTRATIONS ..... - 48 -
2. NATIONAL POLICY ASSURANCES ..... - 49 -
3. ENVIRONMENTAL IMPACT QUESTIONNAIRE ..... - 49 -
4. TECHNOLOGY-TO-MARKET PLAN ..... - 49 -
5. INTELLECTUAL PROPERTY AND DATA MANAGEMENT PLANS ..... - 50 -
6. U.S. COMPETITIVENESS ..... - 50 -
7. CORPORATE FELONY CONVICTIONS AND FEDERAL TAX LIABILITY ..... - 52 -
8. APPLICANT RISK ANALYSIS ..... - 52 -
9. RECIPIENT INTEGRITY AND PERFORMANCE MATTERS ..... - 53 -
10. NONDISCLOSURE AND CONFIDENTIALITY AGREEMENTS REPRESENTATIONS ..... - 53 -
11. INTERIM CONFLICT OF INTEREST POLICY FOR FINANCIAL ASSISTANCE ..... - 54 -
12. COMMERCIALIZATION PLAN AND SOFTWARE REPORTING ..... - 54 -
13. FRAUD, WASTE, AND ABUSE ..... - 55 -
C. REPORTING ..... - 55 -

VII. AGENCY CONTACTS ..... - 55 -

A. COMMUNICATIONS WITH ARPA-E ..... - 55 -
B. DEBRIEFINGS ..... - 56 -

VIII. OTHER INFORMATION ..... - 57 -

A. TITLE TO SUBJECT INVENTIONS ..... - 57 -
B. GOVERNMENT RIGHTS IN SUBJECT INVENTIONS ..... - 57 -
1. GOVERNMENT USE LICENSE ..... - 58 -
2. MARCH-IN RIGHTS ..... - 58 -
C. RIGHTS IN TECHNICAL DATA ..... - 58 -
D. PROTECTED PERSONALLY IDENTIFIABLE INFORMATION ..... - 59 -
E. FOAS AND FOA MODIFICATIONS ..... - 59 -
F. OBLIGATION OF PUBLIC FUNDS ..... - 59 -
G. REQUIREMENT FOR FULL AND COMPLETE DISCLOSURE ..... - 60 -
H. RETENTION OF SUBMISSIONS ..... - 60 -
I. MARKING OF CONFIDENTIAL INFORMATION ..... - 60 -
J. EXPORT CONTROL INFORMATION ..... - 61 -
K. COMPLIANCE AUDIT REQUIREMENT ..... - 61 -
L. PAYMENT OF FEE OR PROFIT ..... - 61 -
M. ADDITIONAL NOTICES ..... - 62 -

IX. GLOSSARY ..... - 63 -

Questions about this FOA? Check the Frequently Asked Questions available at http://arpa-e.energy.gov/faq. For questions that have not already been answered, email ARPA-E-CO@hq.doe.gov (with FOA name and number in subject line); see FOA Sec. VII.A. Problems with ARPA-E eXCHANGE? Email ExchangeHelp@hq.doe.gov (with FOA name and number in subject line).

REQUIRED DOCUMENTS CHECKLIST

For an overview of the application process, see Section IV.A of the FOA.

For guidance regarding requisite application forms, see Section IV.B of the FOA.

For guidance regarding the content and form of Concept Papers, Full Applications, and Replies to Reviewer Comments, see Sections IV.C, IV.D, and IV.E of the FOA.

SUBMISSION	COMPONENTS	OPTIONAL/ MANDATORY	FOA SECTION	DEADLINE
Concept Paper	• Each Applicant must submit a Concept Paper in Adobe PDF format by the stated deadline. The Concept Paper must not exceed 4 pages in length including graphics, figures, and/or tables, and must include the following: ○ Concept Summary ○ Innovation and Impact ○ Proposed Work ○ Team Organization and Capabilities	Mandatory	IV.C	9:30 AM ET, March 19, 2024
Full Application	[TO BE INSERTED BY FOA MODIFICATION IN MAY 2024]	Mandatory	IV.D	9:30 AM ET, TBD
Reply to Reviewer Comments	[TO BE INSERTED BY FOA MODIFICATION IN MAY 2024]	Optional	IV.E	5 PM ET, TBD

I. FUNDING OPPORTUNITY DESCRIPTION

A. AGENCY OVERVIEW

The Advanced Research Projects Agency – Energy (ARPA-E), an organization within the Department of Energy (DOE), is chartered by Congress in the America COMPETES Act of 2007 (P.L. 110-69), as amended by the America COMPETES Reauthorization Act of 2010 (P.L. 111-358), as further amended by the Energy Act of 2020 (P.L. 116-260):

"(A) to enhance the economic and energy security of the United States through the development of energy technologies that—
(i) reduce imports of energy from foreign sources;
(ii) reduce energy-related emissions, including greenhouse gases;
(iii) improve the energy efficiency of all economic sectors;
(iv) provide transformative solutions to improve the management, clean-up, and disposal of radioactive waste and spent nuclear fuel; and
(v) improve the resilience, reliability, and security of infrastructure to produce, deliver, and store energy; and
(B) to ensure that the United States maintains a technological lead in developing and deploying advanced energy technologies."

ARPA-E issues this Funding Opportunity Announcement (FOA) under its authorizing statute codified at 42 U.S.C. § 16538. The FOA and any cooperative agreements or grants made under this FOA are subject to 2 C.F.R. Part 200 as supplemented by 2 C.F.R. Part 910.

ARPA-E funds research on, and the development of, transformative science and technology solutions to address the energy and environmental missions of the Department. The agency focuses on technologies that can be meaningfully advanced with a modest investment over a defined period of time in order to catalyze the translation from scientific discovery to early-stage technology. For the latest news and information about ARPA-E, its programs and the research projects currently supported, see: http://arpa-e.energy.gov/.

ARPA-E funds transformational research. Existing energy technologies generally progress on established "learning curves" where refinements to a technology and the economies of scale that accrue as manufacturing and distribution develop drive improvements to the cost/performance metric in a gradual fashion. This continual improvement of a technology is important to its increased commercial deployment and is appropriately the focus of the private sector or the applied technology offices within DOE. In contrast, ARPA-E supports transformative research that has the potential to create fundamentally new learning curves. ARPA-E technology projects typically start with cost/performance estimates well above the level of an incumbent technology. Given the high risk inherent in these projects, many will fail to progress, but some may succeed in generating a new learning curve with a projected cost/performance metric that is significantly better than that of the incumbent technology.

ARPA-E funds technology with the potential to be disruptive in the marketplace. The mere creation of a new learning curve does not ensure market penetration. Rather, the ultimate value of a technology is determined by the marketplace, and impactful technologies ultimately become disruptive – that is, they are widely adopted and displace existing technologies from the marketplace or create entirely new markets. ARPA-E understands that definitive proof of market disruption takes time, particularly for energy technologies. Therefore, ARPA-E funds the development of technologies that, if technically successful, have clear disruptive potential, e.g., by demonstrating capability for manufacturing at competitive cost and deployment at scale.

ARPA-E funds applied research and development. The Office of Management and Budget defines "applied research" as an "original investigation undertaken in order to acquire new knowledge…directed primarily towards a specific practical aim or objective" and defines "experimental development" as "creative and systematic work, drawing on knowledge gained from research and practical experience, which is directed at producing new products or processes or improving existing products or processes."[1] Applicants interested in receiving financial assistance for basic research (defined by the Office of Management and Budget as "experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts")[2] should contact the DOE's Office of Science (http://science.energy.gov/). Office of Science national scientific user facilities (http://science.energy.gov/user-facilities/) are open to all researchers, including ARPA-E Applicants and awardees. These facilities provide advanced tools of modern science including accelerators, colliders, supercomputers, light sources and neutron sources, as well as facilities for studying the nanoworld, the environment, and the atmosphere. Projects focused on early-stage R&D for the improvement of technology along defined roadmaps may be more appropriate for support through the DOE applied energy offices including: the Office of Energy Efficiency and Renewable Energy (http://www.eere.energy.gov/), the Office of Fossil Energy and Carbon Management (https://www.energy.gov/fecm/office-fossil-energy-and-carbon-management), the Office of Nuclear Energy (http://www.energy.gov/ne/office-nuclear-energy), and the Office of Electricity (https://www.energy.gov/oe/office-electricity).

B. SBIR/STTR PROGRAM OVERVIEW

The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs are Government-wide programs authorized under Section 9 of the Small Business Act (15 U.S.C. § 638). The objectives of the SBIR program are to (1) stimulate technological innovation in the private sector, (2) strengthen the role of Small Business Concerns in meeting Federal R&D needs, (3) increase private sector commercialization of innovations derived from Federal R&D activities, (4) foster and encourage participation by socially and economically disadvantaged and women-owned Small Business Concerns, and (5) improve the return on

[1] OMB Circular A-11 (https://www.whitehouse.gov/wp-content/uploads/2018/06/a11_web_toc.pdf), Section 84, pg. 3.

[2] OMB Circular A-11 (https://www.whitehouse.gov/wp-content/uploads/2018/06/a11_web_toc.pdf), Section 84, pg. 3.

investment from Federally funded research and economic benefits to the Nation. The objective of the STTR program is to stimulate cooperative partnerships of ideas and technologies between Small Business Concerns and partnering Research Institutions through Federally funded R&D activities.[3]

ARPA-E administers a joint SBIR/STTR program in accordance with the Small Business Act and the SBIR and STTR Policy Directive issued by the U.S. Small Business Administration (SBA).[4] ARPA-E provides SBIR/STTR funding in three phases (Phase I, Phase II, and Phase IIS).

C. PROGRAM OVERVIEW

1. BACKGROUND

Motivation

The electric vehicle (EV) market is growing rapidly. Although globally, a modest 3% of passenger vehicles on the road are electric, the number is expected to increase to 28% by 2030 and 58% by 2040.[5] The EV revolution will be driven primarily by a combination of the following considerations:

- Consumer demand for cleaner vehicles;
- Fluctuations and uncertainties in the price of gasoline;
- Reductions in the price of EVs;
- Emerging legislation that may limit or even prohibit the sale of internal combustion engine vehicles; and
- Financial incentives to purchase EVs in the form of rebates and/or tax credits.

The most critical factor motivating EV adoption by consumers may be more attractive economics made possible by significant reductions in the cost of lithium-ion battery (LIB) packs. Already, prices have decreased from approximately $1,300 per kilowatt-hour (kWh) in 2010 to about $150/kWh in 2022 and are projected to fall below $80/kWh by 2030.[5] This reduction in pack cost has been achieved through economies of scale, improved manufacturing processes, and the introduction of new battery chemistries that reduce or eliminate the requirement for critical and expensive minerals, particularly cobalt.[6]

---

[3] Research Institutions include FFRDCs, nonprofit educational institutions, and other nonprofit research organizations owned and operated exclusively for scientific purposes. Eligible Research Institutions must maintain a place of business in the United States, operate primarily in the United States, or make a significant contribution to the U.S. economy through the payment of taxes or use of American products, materials, or labor.

[4] See 85 Fed. Reg. 50062 (Aug. 17, 2020).

[5] Bloomberg NEF. (n.d.). *Electric Vehicle Outlook 2023*. https://about.bnef.com/electric-vehicle-outlook/

[6] Wood Mackenzie. (2022, March 22). *Global lithium-ion battery capacity to rise five-fold by 2030*. https://www.woodmac.com/press-releases/global-lithium-ion-battery-capacity-to-rise-five-fold-by-2030/

Current EV manufacturing practices have been established along a linear economic model of "take, make, use, and dispose" with negligible consideration for battery end of life (EOL). However, significant increases in the number of EVs will be accompanied by large volumes of battery waste, albeit with a 10-to-20-year lag, depending on both the type of battery and conditions of use. The disposal of spent batteries is challenging due to fire hazards and/or potential releases of toxic chemicals into the environment. The existing supply chain for EV batteries relies mostly on recycling to close the loop to recover a fraction of critical minerals. However, conventional battery recycling methods such as pyrometallurgy and hydrometallurgy are energy-intensive, produce significant quantities of greenhouse gases (GHGs), and lead to large volumes of waste deposited in landfills. These approaches require shredding cell modules or whole batteries, and with few exceptions, intentionally recover only the most valuable materials (e.g., nickel, cobalt, and copper). Although direct recycling[7] is less energy intensive and has a smaller carbon footprint than pyrometallurgical and hydrometallurgical processes,[8] it also requires shredding and thus destroys the embedded manufacturing value of spent battery packs and their constituent components.

These recycling strategies are expected to endure increasingly challenging economics as battery chemistries that rely on more abundant and/or less expensive minerals capture increasingly significant market share. For instance, lithium iron phosphate (LFP) has made inroads into the EV battery market in recent years.[5] Prolonging the service life of EV batteries and recovering the manufacturing value of spent batteries to the greatest extent possible through regeneration, repair, reuse, and remanufacture will reduce the demand for critical minerals, as well as the domestic energy burden and the subsequent carbon footprint of the EV battery supply chain. Figure 1 illustrates the different approaches that can be developed to achieve a circular EV battery supply chain including swapping, regenerating, repairing, and remanufacturing. Here, recycling is considered a process of last resort.

[7] Gaines, L., Dai, Q., Vaughey, J. T., & Gillard, S. (2021). Direct Recycling R&D at the ReCell Center. *Recycling, 6*(2), 31. https://doi.org/10.3390/recycling6020031

[8] Gaines, L., Richa, K., & Spangenberger, J. (2018). Key issues for Li-ion battery recycling. *MRS Energy & Sustainability*, *5*, E14. https://doi.org/10.1557/mre.2018.13

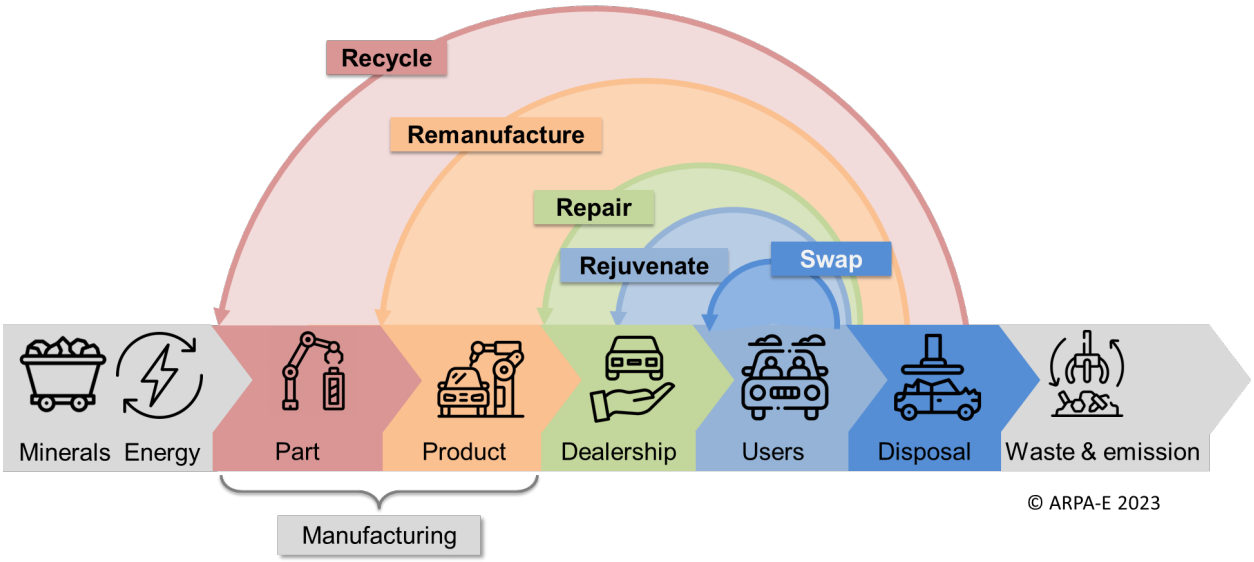


Figure 1. Illustration of the current linear EV supply chain and different strategies to achieve a circular EV battery alternative with recycling as a process of last resort.

Lessons Learned from Lead-Acid Batteries

The supply chain for commercial lead-acid batteries used in ICE vehicles is frequently highlighted as an example of a successful circular supply chain achieved solely through recycling.[9] First, ninety-nine percent of lead-acid batteries are recycled in the U.S.[10] This is due, in part, to an efficient and incentivized recovery strategy where owners can exchange spent batteries towards the purchase of a new ones at a discounted price. Second, lead-acid batteries use an aqueous electrolyte and electrodes in the form of millimeter thick lead (Pb) and lead oxide (PbO_2) plates. This simple design and chemical composition enable facile separation of electrodes, electrolyte, and plastic casing for recycling.[11] However, lead-acid battery recycling is an energy intensive process that includes comminution, melt-processing and extrusion of plastics, and smelting of lead-containing components.[12] The practice also raises major concerns over environmental contamination and human exposure to toxic lead.

Effective methods exist for regenerating lead-acid batteries. For example, these batteries may degrade due to lead sulfate ($PbSO_4$) crystal formation on the Pb electrode during discharge. Upon deep discharge, or if the battery is left discharged for a long time, a hard and thick layer of $PbSO_4$ can grow and significantly reduce the battery's performance. Several methods have

[9] Gaines, L. (2014). The future of automotive lithium-ion battery recycling: Charting a sustainable course. *Sustainable Materials and Technologies, 1-2*, 2-7. https://doi.org/10.1016/j.susmat.2014.10.001

[10] Battery Council International. (2014, April 1). *National Recycling Rate Study – an impressive 99%*. Gopher Resource. https://www.gopherresource.com/newsroom/national-recycling-rate-study.html

[11] Battery Council International. (2023, July). National Recycling Rate Study. https://batterycouncil.org/resource/national-recycling-rate-study/

[12] Battery Council International. (n.d.). *How a Lead Battery Is Recycled*. https://batterycouncil.org/recycling-sustainability/how-a-lead-battery-is-recycled/

been shown to regenerate Pb electrodes by reversing $PbSO_4$ formation. Pulse conditioning consists of imposing a high voltage pulse which electrochemically reverses the $PbSO_4$ formation reactions without causing excessive heating. Alternatively, adding chemicals to the sulfuric acid electrolyte can help remove the $PbSO_4$ layer.

The supply chain model for lead-acid batteries is difficult to reproduce for LIB packs. For example, LIB uses of flammable, reactive, and hazardous organic electrolytes instead of water. They exhibit architectural and compositional complexity of thin film electrodes and have a significantly higher energy content. Despite this, EV batteries may be able to emulate some of the following lead-acid battery design features to promote circularity:

- The ability to swap one battery pack for another;
- The ability to prolong battery life by regenerating electrode materials *in situ* (e.g., pulse conditioning, chemical treatment) and/or by replenishing the electrolyte;
- The simplicity of the materials chemistry, design, and manufacturing which makes batteries easy to disassemble and to separate the anodes, cathodes, electrolyte, as well as casing to facilitate repair, remanufacture, and recycling; and
- The standardization of battery chemistry and form factor.

Technology Needs for a Circular EV Battery Supply Chain

A major shift in conventional thinking and operation is required to realize a truly circular EV battery supply chain with innovations and practices that consider EOL while recognizing the need for recycling as a process of last resort. The following sections briefly discuss examples of materials, designs, and manufacturing strategies that may contribute to the development of a circular EV battery supply chain. The topics highlighted in the following sections are illustrative examples of potential solutions capable of achieving the Catalyzing Innovative Research for Circular Use of Long-lived Advanced Rechargeables (CIRCULAR) program objectives. Note that there is no preference in favor of these specific approaches nor against other possibilities not explicitly mentioned. Figure 2 depicts the program's vision of the circular EV supply chain that may be achieved through the innovative technologies and business models discussed in the next sections.

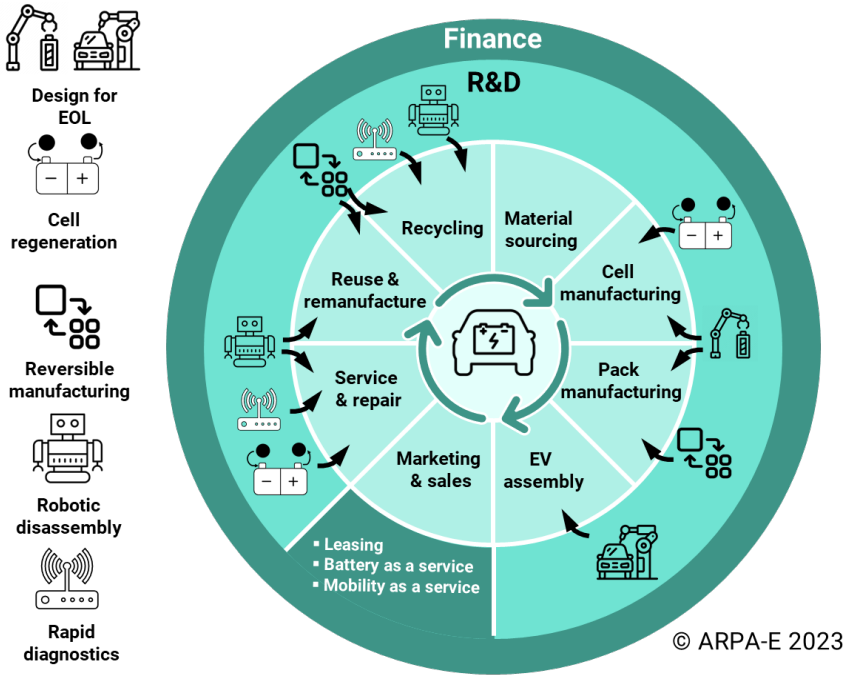


Figure 2. Illustration of the research and development needs and financial strategies that can be deployed along a circular EV battery supply chain.

Prolonging Battery Cell Life

Battery degradation may proceed through different chemical pathways depending on the selection of electrode materials, electrolyte compositions, cell designs, and cycling conditions. For example, rapid charging of conventional LIBs in cold temperatures can result in undesired lithium plating and dendrite formation at the graphite anode due to sluggish lithium intercalation and phase transitions. In turn, this phenomenon leads to a loss of active lithium inventory as lithium ions (Li^+) no longer participate in reversible redox reactions. Conceivably, strategies capable of efficiently and cost-effectively limiting degradation mechanisms and/or regenerating battery materials to their beginning of life (BOL) performance are promising options for extending the service life of individual battery cells in support of circularity. Such techniques can be performed *ex situ* or *in situ*, although the latter may be more desirable from an implementation perspective. To date, limited investigative effort has been dedicated to these approaches, which also necessitate innovations in cell design depending on the battery chemistry and the methods used to prolong battery life. Arguably, cell regeneration would be most valuable for electrode materials that degrade more rapidly than others, including mixed metal oxides of nickel, manganese, cobalt, or aluminum (e.g., NMC or NCA) conventionally used in LIBs. Finally, safety of the redesigned cells during fabrication, operation, and regeneration should be maintained according to current industry standards.

Reversible Manufacturing for Easy Repair, Upgrade, Reuse, and Remanufacture

Battery pack repair and remanufacture promote circularity of the EV battery supply chain through replacement of defective and/or deteriorated components. Within each aging, defective, or spent battery pack there may exist individual salvageable battery cells, modules, and components which could potentially be economically recovered, reused, or recycled, and in all cases removed from waste streams. Reincorporating these salvaged components into new or refurbished battery packs preserves their embedded manufacturing value. A recycling stream consisting of only spent cells would yield black mass with a higher concentration of critical materials and therefore higher recycling value per unit mass. Simple, rapid, and safe disassembly procedures could additionally facilitate rework of defective battery packs during production, and thereby reduce the quantity of scrap generated by gigafactories. Streamlined disassembly could also enable the replacement of aging battery pack components as a preventative measure or to improve performance.

Battery repair may be more intrusive, time consuming, and expensive compared to *in situ* battery regeneration, but could still be performed by qualified technical staff in specialized facilities or dealership service departments. This approach would benefit from a holistic design of EVs and battery packs and a judicious selection of materials and manufacturing methods, which would promote safe and convenient disassembly to access components that are more prone to failure earlier in life, e.g., the battery management system (BMS) or cooling pump.

Representative technical approaches to realize so-called "reversible manufacturing," which refers to the ability to "unmanufacture" battery packs as rapidly or easily as they are manufactured, include the following:

- Design for Reversible Assembly: Existing battery packs that were not originally designed with the EOL in mind require arduous and time-consuming disassembly processes during recycling. By contrast, sustainable designs would enable individual cells, BMS, thermal management components, etc., to be easily isolated, serviced, reused, replaced, and upgraded. Then, only defective cells and deteriorated components that have reached their EOL would require recycling, instead of shredding entire modules or packs. Moreover, a modular design would make this solution highly scalable.
- High Strength "Debondable" Adhesives: Adhesives are critical to the safe and reliable operation of EV batteries by ensuring that cells, modules, and other critical pack components can withstand mechanical vibrations and shocks. Successful application of high strength, debondable adhesives with equivalent performance to conventional adhesives used in commercial battery packs would simplify disassembly. In principle, stimuli-responsive systems that react to specific wavelengths of light, ultrasound, electric and/or magnetic fields, etc., may be leveraged to achieve clean and controlled debonding of battery pack adhesives.
- Reversible Welding and Joining Techniques: Welding is the conventional joining technique employed in battery packs primarily due to its long-term durability, mechanical strength, and low interfacial electrical resistance. Effective and scalable strategies for reversible welding or more generally reversible joining of cells, modules,

> and other battery pack components would facilitate recovery of individual cells. Battery pack designs that circumvent the requirement for permanent joining, either partially or entirely, would be especially advantageous for separating battery packs into individual components. For example, compression technology could be utilized to reduce the number of permanently bonded components while mitigating the risk that fasteners loosen over time.[13]

Sustainable designs, innovative materials, and reversible manufacturing techniques can enable the safe and rapid manual disassembly of batteries for repair, reuse, remanufacture, and recycling. A complementary or alternative approach to manual disassembly could rely on autonomous robotic disassembly of battery packs.

Autonomous Robotic Disassembly

Currently, manual disassembly of battery packs into individual modules typically takes several hours due to complex, irreversible designs and manufacturing, including welded parts and the use of permanent adhesives that are difficult to remove. The high voltage of EV batteries (400 V to 800 V) is also a major safety concern, complicating manual disassembly even when performed by highly trained technicians. Therefore, robotic disassembly of battery packs may be a promising option to increase safety and throughput and simultaneously reduce the cost of repair, reuse, remanufacturing, and recycling, thereby enabling scalable solutions capable of handling the projected future growth of spent EV battery volumes.

Given the wide variety of battery pack designs and manufacturing methods among EV models and their evolution over time, as well as the potential degradation of battery packs during use (e.g., rusty bolts), robotic disassembly should be able to autonomously select, evaluate, and adapt unmanufacturing processes for each EV battery pack. Such autonomous robotic disassembly systems should have the ability to learn from their own experiences, from those of other robots, or from simulations, videos, or other media. Strategies may also need to be developed to coordinate the disassembly of battery packs cooperatively between robots and humans. This vision could be achieved by leveraging recent advances in artificial intelligence and machine learning, for example. Finally, inspection of the battery pack to determine geometric parameters, aging conditions, and potential defects that could compromise safety may be necessary prior to attempting robotic disassembly. The design and manufacture of battery packs may need to be modified to enable the practical implementation of these approaches.

Rapid State of Health Diagnostics

Quantifying the state of health (SOH) and remaining useful life (RUL) of individual cells or modules either continuously during operation within the battery pack, at specific times during repair, and/or at EOL at the pack- or cell-levels, is critical for deciding whether cells should be

[13] Chandan, A., & Cummins, C. (2022, February 24). BATTERY PACK ASSEMBLY (2022/0059898 A1). https://www.freepatentsonline.com/y2022/0059898.html

regenerated, reused/repurposed, or recycled.[14,15] Such determinations must be made rapidly and reliably and be capable of diagnosing a wide variety of commercial battery cell chemistries and form factors. Relying on traditional electrochemical methods that require several hours to charge and discharge cells at slow rates is impractical for determining SOH and RUL, especially considering the anticipated future volume of spent EV batteries. Several rapid diagnostic techniques have been explored including, but not limited to, electrochemical impedance spectroscopy measurements and ultrasound techniques[16] both combined with physics-based models, data-driven models, and artificial intelligence.[14, 15,17] Finally, SOH, RUL, and other diagnostics performed during normal EV operation could be used to inform the BMS in performing restorative measures to prolong the life of individual cells and/or modules, thus achieving the circularity objectives.[18]

Overall, there is a critical need for technological innovations that can be both practically and economically implemented at commercially relevant scales to achieve a circular EV battery supply chain. A diverse array of solutions could be adopted separately, in combination with others, and/or at different times or stages along the battery supply chain. It is expected that introducing new materials and sensing methods, leveraging cell-level life-prolonging strategies, envisioning innovative cell and pack designs, and adopting new reversible manufacturing methods will be challenging for industry, since implementation will likely lower yield and increase capital expenses, at least initially. Despite short-term economic barriers, there is an immediate and critical need to accelerate development of enabling technologies and solutions to catalyze the transition from a linear to a circular supply chain for domestic EV batteries. Chemistry-agnostic technologies are particularly relevant given the current and future diversity of EV battery chemistries.

D. PROGRAM OBJECTIVES

According to the U.S. Environmental Protection Agency (EPA),[19] a circular economy "refers to an economy that uses a systems-focused approach and involves industrial processes and economic activities that are restorative or regenerative by design, enables resources used in

[14] Wang, Z., Zhao, X., Fu, L., Zhen, D., Gu, F., & Ball, A. D. (2023). A review on rapid state of health estimation of lithium-ion batteries in electric vehicles. *Sustainable Energy Technologies and Assessments, 60*, 103457.

[15] Ge, M.-F., Liu, Y., Jiang, X., & Liu, J. (2021). A review on state of health estimations and remaining useful life prognostics of lithium-ion batteries. *Measurement, 174*, 109057. https://doi.org/10.1016/j.measurement.2021.109057

[16] Bommier, C., Chang, W., Lu, Y., Yeung, J., Davies, G., Mohr, R., Williams, M., & Steingart, D. (2020). In Operando Acoustic Detection of Lithium Metal Plating in Commercial LiCoO2/Graphite Pouch Cells. *Cell Reports Physical Science, 1*(4), 100035. https://doi.org/10.1016/j.xcrp.2020.100035

[17] Zhang, Y., Tang, Q., Zhang, Y., Wang, J., Stimming, U., & Lee, A. A. (2020). Identifying degradation patterns of lithium ion batteries from impedance spectroscopy using machine learning. *Nature Communications, 11*(1), 1706. https://doi.org/10.1038/s41467-020-15235-7

[18] Alba, M. (2023, October 31). *New Charging Method Can Quadruple Battery Performance, Startup Claims*. Engineering.com. https://www.engineering.com/story/new-charging-method-can-quadruple-battery-performance-startup-claims

[19] U.S. Environmental Protection Agency. (n.d.). *What is a Circular Economy?* https://www.epa.gov/circulareconomy/what-circular-economy

such processes and activities to maintain their highest value for as long as possible, and aims for the elimination of waste through the superior design of materials, products, and systems." Further, "a circular economy reduces material use, redesigns materials, products, and services to be less resource intensive, and recaptures 'waste' as a resource to manufacture new materials and products." Successfully achieving a circular economy requires implementing the above principles to the supply chains of numerous products.

Specifically, creating a circular EV battery supply chain focuses on optimizing the full vehicle life cycle. Thus, the emphasis must shift from production and sales within an ownership model to a model focusing on customers' mobility needs and access in the form of leasing, as it exists today, vehicle-on-demand (e.g., Zipcar®), and mobility-on-demand (e.g., robotaxis).[20] These different business models may coexist but will require increasing collaboration and transparency among different actors, while costs and revenues will be distributed across the supply chain.

A circular supply chain offers new revenue streams and business opportunities[20] by providing services to maximize EVs' lifetime performance through:

- Enhancing regular predictive maintenance;
- Repairing and remanufacturing of battery modules and packs;
- Improving the reuse and recovery of EOL parts and materials; and
- Minimizing carbon footprint and maximizing resource efficiency.

A circular supply chain also offers opportunities to reduce production and operating costs[20] by:

- Improving the quality and stability of critical minerals' supply chains through cell regeneration, reuse, and recycling;
- Facilitating rework, reuse, repair, and remanufacture of batteries through modular designs, reversible manufacturing materials and methods; and
- Reducing asset costs per unit amount of energy delivered owing to the retention of the embedded manufacturing value of batteries, their prolonged lifetime, and the extended use of EVs.

The overarching goal of the CIRCULAR program is to successfully translate the above definition of a circular economy to the domestic EV battery supply chain by supporting the development of innovative solutions that can overcome both the technological and economic barriers to broad commercial adoption. CIRCULAR acknowledges that simultaneous advancements in multiple technological domains may be required to accomplish this ambitious objective. Therefore, the program is intentionally structured into three technology development categories designed to converge towards the creation of a domestic circular supply chain for EV batteries (Section I.D).

The CIRCULAR program recognizes that conventional recycling is not the only, nor primary, pathway to closing the supply chain loop. Therefore, the primary objective of this program is to

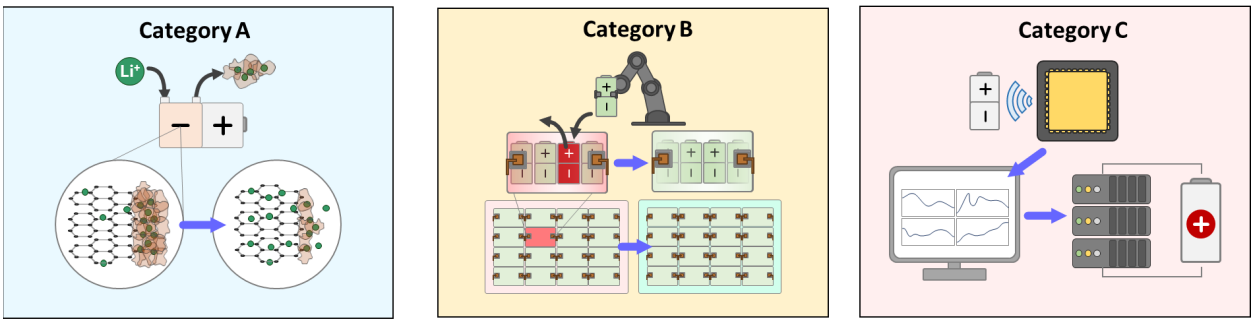
[20] World Economic Forum. (2022, May). *Driving Ambitions: The Business Case for Circular Economy in the Car Industry, Insight Report*. https://www3.weforum.org/docs/WEF_Driving_Ambitions-2022.pdf

catalyze the creation of a circular EV battery supply chain in North America. The program will support the development and deployment of foundational technologies capable of maintaining materials and products in circulation at their highest level of performance and safety for as long as possible. Achieving this goal will directly impact ARPA-E mission areas as follows:

- **Decrease Energy-Related Imports:** The CIRCULAR program aims to reduce the import of critical battery materials, cells, packs, and EVs by establishing new supply chain loops within the U.S. Currently, individual steps in the battery supply chain (mining, material processing, cell component assembly, battery cell manufacturing, and recycling) are concentrated mostly outside of the U.S.
- **Reduce Emissions:** The CIRCULAR program aims to decrease the domestic energy burden and carbon footprint of the EV battery supply chain by extending the service life of battery cells and packs and by maintaining manufacturing value to the greatest extent possible through regeneration, repair, reuse, and remanufacture. The program will also reduce emissions associated with battery recycling by minimizing the amount of waste and by recycling only pack components that have reached their EOL.
- **Improve Energy Efficiency:** The CIRCULAR program aims to minimize energy and material consumption within the battery supply chain and to exploit opportunities to improve energy efficiency through innovative battery design, material regeneration, and/or manufacturing strategies.

E. TECHNICAL CATEGORIES OF INTEREST

The CIRCULAR program is structured into three distinct technical categories, as illustrated in Figure 3. Category A encompasses primarily materials, designs, and regeneration strategies that can be implemented at the battery cell level for the purpose of extending service life. Category B emphasizes innovations at the battery pack level including new materials, designs, and reversible manufacturing techniques to facilitate pack disassembly and recovery of manufacturing value. In addition, autonomous robotic disassembly is highlighted as a practical and economic option to safely manage disassembly operations for large EV battery pack inventories. Category C prioritizes the development and integration of advanced sensing technologies capable of monitoring the SOH of individual cells, associated data analytics, and battery intelligence systems to extend the service life of cells, modules, and packs.



Materials, Cells Designs, & Methods for Extending Cell Life | **Reversible Manufacturing & Safe, Easy Pack Disassembly** | **Sensing, Data Analytics, Battery Intelligence Systems**

Figure 3. Illustration of the three technical categories of the CIRCULAR program.

Category A is divided into two subcategories, designated A1 and A2, that are defined by discrete ranges for cell-level specific energy density to differentiate between proposed battery chemistries and corresponding technical targets. In subcategory A1, the cell specific energy ranges between 175 to 225 Watt-hours per kilogram (Wh/kg), while in subcategory A2, the cell specific energy is equal to or exceeds 225 Wh/kg. Note that, despite differences in specific energies, circularity metrics for both subcategories aim to achieve the same total amount of energy delivered over the cell lifetime. Category A seeks innovations in battery cell materials, designs, regeneration methods, and corresponding manufacturing techniques to prolong battery service life including, but not limited to, the following:

- Methods and apparatuses to limit degradation of cell performance;
- Battery materials amenable to *in situ* regeneration;
- Regeneration methods and/or operations to cost-effectively restore cells to BOL performance and safety; and
- Cell designs that enable implementation of regeneration methods at scale.

Category B seeks innovations in battery pack designs, materials, and reversible manufacturing methods as well as fast and safe disassembly techniques to recover manufacturing value of cells and pack components including, but not limited to, the following:

- Battery pack designs and reversible manufacturing techniques to facilitate battery pack disassembly to the cell-level;
- Materials and methods to enable reversible manufacturing (e.g., debondable adhesives or reversible joining methods); and
- Autonomous robotic disassembly of battery packs.

Category C seeks innovations in cell-level sensing, data analytics, and battery intelligence systems for circularity and safety including, but not limited to, the following:

- Sensing methods for rapid SOH and RUL determination of individual cells during operation and/or at EOL;

- Seamless and cost-effective integration of sensors during cell (Category A) and pack (Category B) manufacturing;
- Data analytics and battery intelligence systems to enable predictive maintenance and/or to extend the service life of cells, modules, and packs;
- Data-driven guidance to determine the fate of individual cells, i.e., regeneration, repair, reuse, or recycling; and
- Advanced diagnostic tools and techniques to identify damaged and potentially hazardous cells.

F. TECHNICAL PERFORMANCE TARGETS

The primary technical and cost metrics for Categories A, B, and C of the **CIRCULAR** program are summarized in Tables 1, 2 and 3, respectively. Additional details, including definitions of individual metrics, are provided in the section below each table.

Category A

Table 1. Description of primary metrics and targets for Category A.

METRIC DESCRIPTION	STATE OF THE ART (SOA)	TARGET	
		SUBCATEGORY A1	SUBCATEGORY A2
Cell Specific Energy E_D (Wh/kg/cycle)[a]	< 175	≥ 175 to ≤ 225	≥ 225
Cell Chemistry[b]	LFP	Reported by Applicant	Reported by Applicant
NEW CELLS – BASELINE PERFORMANCE			
Initial Number of Cycles N_i[c]	< 3000	≥ 3000	≥ 1500
Test Cell Capacity[d]	Variable	≥ 1 Ah	≥ 1 Ah
Safety[e]	Yes	Yes	Yes
LIFE-PROLONGING METHODS			
Additional Number of Cycles N_a[f]	N/A	≥ 3000	≥ 3000
Cost of Life-Prolonging Method (fraction of initial cost/kWh/cell)[g]	N/A	≤ 10%	≤ 10%
GHG emissions (kg CO_2/kWh)[h]	N/A	Reported by Applicant	Reported by Applicant
Safety[i]	N/A	Yes	Yes
CIRCULARITY METRICS			
Overall Energy Delivered During Cell Lifetime E_T (kWh/kg)[j]	< 525	> 1000	> 1000
Cell Lifetime Energy Cost ($/kWh Delivered)	0.04-0.05	≤ 50% SOA	≤ 50% SOA
Cell Lifetime GHG Emissions (kg CO_2/kWh Delivered)	25-30[k]	≤ 50% SOA	≤ 50% SOA

[a] Specific energy (Wh/kg) is defined at a C/3 discharge rate (at 30°C) for a cell charged to the recommended charge voltage for a C/3 rate. Note this is a cell-level value (not materials-level) and therefore considers all functional materials, components, and packaging. Achievable value for cell-level specific energy can be calculated based on a cell larger than the 1 Ah capacity cell required for testing during this project. Additional clarification on test protocols is available from the United States Advanced Battery Consortium (USABC) procedure.[21] Battery chemistries that have a pathway to achieving a cell-level specific energy at BOL ≥175 Wh/kg are appropriate options for Category A. Applicants should note that the targets for "NEW CELLS – BASELINE PERFORMANCE," "LIFE-PROLONGING METHODS," and "CIRCULARITY" in Table 1 depend directly on the specific energy of the proposed chemistry (i.e., ≥175 to ≤225 Wh/kg (subcategory A1), ≥225 Wh/kg (subcategory A2)). Stated alternatively, proposed battery chemistries are expected to meet or exceed the metrics for either A1 or A2, depending upon the corresponding specific energy. Note that although LFP is included in the table as a reference, it is not intended to convey a preference or requirement for any battery chemistry.

[b] Battery chemistry is selected and disclosed by the applicant. Applicant should identify and, as appropriate, provide descriptions of the anode, cathode, and electrolyte (organic or aqueous liquid, solid-state, etc.).

[c] Number of cycles to 80% capacity relative to BOL capacity for a new cell; cycling tests performed according to USABC protocols. Applicants should note that the target value for the "Initial Number of Cycles" metric is dependent on the original specific energy for new cells. Cycle life projections based on validated accelerated testing protocols and/or extrapolation from a combination of experimental cycling data and calculated degradation rates may be considered in lieu of an experimentally proven number of initial cycles target requirement.

[d] BOL capacity of a cell used to confirm effectiveness of cell regeneration strategy; smaller capacity cells may be used for proof-of-concept initially; cell design/form factor must be amenable to the regeneration process.

[e] New cells featuring a proposed chemistry must show a pathway to passing industry standard cell safety tests,[22, 23] although it is understood that constraints may exist on organizational capabilities to conduct safety testing either internally or externally through third parties. Therefore, a discussion of the types and scope of standard safety testing that is planned should be included in the submission and will be discussed during the project negotiations phase for selected projects.

[f] Number of additional cycles to 80% capacity relative to BOL capacity for a regenerated cell; cycling tests performed according to USABC protocols; cycling rates and all other conditions should be identical to those used for cycle life testing of new cells. Applicants should note

---

[21] United States Council for Automotive Research (https://uscar.org/usabc/)

[22] Underwriters Laboratories, Inc. (n.d.). *Safety Issues for Lithium-Ion Batteries*. https://code-authorities.ul.com/wp-content/uploads/2016/02/Safety_Issues_for_Lithium_Ion_Batteries1.pdf

[23] Chen, Y., Kang, Y., Zhao, Y., Wang, L., Liu, J., Li, Y., Liang, Z., He, X., Li, X., Tavajohi, N., & Li, B. (2021). A review of lithium-ion battery safety concerns: The issues, strategies, and testing standards. *Journal of Energy Chemistry, 59*(2095-4956), 83–99. https://doi.org/10.1016/j.jechem.2020.10.017

that the target value for the "Additional Number of Cycles" metric (≥ 3000 for Subcategories A1 and A2) does not need to be accomplished through a process performed only a single time. Stated alternatively, the 3000 additional cycle requirements can be achieved by multiple regeneration processes, although a minimum number to achieve the target is preferred due to practical and economic factors. Cycle life projections based on validated accelerated testing protocols and/or extrapolation from a combination of experimental cycling data and calculated degradation rates may be considered in lieu of an experimentally shown number of additional cycles target requirement.

[g] Relative to cost for producing a new cell; cell level costs can be calculated using the Argonne BatPaC model for a 20 Ah cell.[24]

[h] GHG emissions associated with carrying out the required regeneration process(es) to achieve the cycle life target.

[i] Regenerated cell featuring proposed chemistry must be able to pass standard cell safety tests.

[j] The overall energy delivered during cell lifetime E_T (kWh/kg) is approximated as $E_T = (N_i + N_a)E_D/1000$ where E_D is the cell-level specific energy density (Wh/kg) while N_i and N_a are the initial and additional numbers of cycles, respectively.

[k] Value estimated from projections by M. Linder, T. Nauclér, S. Nekovar, A. Pfeiffer, and N. Vekić, *The race to decarbonize electric-vehicle batteries*, McKinsey, Feb. 2023.

Category B

Table 2. Description of primary metrics and targets for Category B.

METRIC DESCRIPTION[a]	TARGET
Capacity of Proposed Modular Reduced-Scale Battery Pack (kWh)	≥ 10
Total Cost of New Pack at Scale ($/kWh)[b]	≤ 120
GHG Emissions of Pack Production at Scale (kg CO_2/kWh)[c]	≤ 20
METRICS FOR REVERSIBLE MANUFACTURING AND DISASSEMBLY	**TARGET**
Time for Disassembly of Reduced-Scale Pack to Cells (minutes)[d]	≤ 30
Time for Remanufacturing the Reduced-Scale Pack (minutes)[d]	≤ 30
Overall Recovery Rate of Cells and Components (wt.%)[d]	≥ 80
Cost of Remanufactured Pack Production at Scale ($/kWh)[e]	≤ 80
GHG Emissions from Remanufactured Pack (kg CO_2/kWh)[f]	< 50%
CIRCULARITY METRICS	**TARGET**
Mass of pristine material used (kg/kWh)	Reported by Applicant
Adhesive materials and their specification(s)	Reported by Applicant
Reversible joining method(s)	Reported by Applicant

[a] Pack design should simultaneously consider battery cell chemistry and form factor, ease of disassembly including application of reversible adhesives and/or joining techniques, as appropriate, without compromising battery pack performance, durability, or safety. Note

[24] Argonne National Laboratory. (n.d.). *BatPaC Model Software*. https://www.anl.gov/cse/batpac-model-software

that for demonstration of pack disassembly, "nonactive" cells can be used. Also, partial technical solutions (debondable adhesives, reversible joining techniques, etc.) are encouraged without a requirement to show disassembly of a full battery pack. However, the merits of any proposed partial solution will be critically evaluated within a "pack disassembly" context.

[b] Applicants are encouraged to use the Argonne BatPaC model for informing calculation of battery pack costs.

[c] M. Linder, T. Nauclér, S. Nekovar, A. Pfeiffer, and N. Vekić, *The race to decarbonize electric-vehicle batteries*, McKinsey, Feb.2023.

[d] Relevant to "reversible manufacturing" concept.

[e] Represents >30% cost reduction compared to SOA.

[f] Percentage reduction relative to a new pack manufactured from pristine materials.

Category C

Table 3. Description of primary metrics and targets for Category C.

METRIC DESCRIPTION	TARGET
HARDWARE	
Sensing Method and Variable(s) of Interest (e.g., State of charge (SOC), SOH, RUL)[a]	Reported by Applicant
Practical Implementation of Proposed Sensing Method[b]	Reported by Applicant
Sensor Technology Accuracy and Precision Compared to SOA Method(s)[c]	≥ 95%
Time for State Determination (Sensing + Algorithm)	≤ 10 minutes
Frequency of False Negative or False Positive Results	< 1/1000
Long-Term Chemical and Thermal Stability[d]	Pass
Sensor Lifetime[e]	Exceed Battery Lifetime
DATA ANALYTICS	
Hardware and/or Software Cost at Scale	≤ 1 % of Pack Cost
Location for Data Storage and Processing	Onboard
Number of Additional Cycles Compared with SOA without Sensor and Battery Management Software[f]	≥ 500
Data Management Protocol with BMS & Onboard Central Processing Unit (Privacy/Cybersecurity)	Reported by Applicant
Accuracy of Prediction of Catastrophic Failure	Reported by Applicant
Algorithm to Decide Cell Handling (Regenerate, Reuse, Recycle)	Reported by Applicant

[a] Submissions must indicate the type of sensor/sensing strategy proposed, supported by a detailed discussion on the type(s) of cell-level information that is/are accessible as well as both the merits and limitations of the approach. Possible examples of cell-level information that may be useful include determination of cell voltage, resistances, temperature, temperature gradients, SOC, SOH, RUL, etc.

[b] Submissions must discuss how the proposed cell-level sensing method will be implemented in practice including whether it will be performed continuously during operation, at specific times during repair, and/or at the EOL, as well as whether cells are located inside or outside the pack.

[c] SOA methods used for validation may include a combination of more established charge and discharge methods and other previously validated rapid diagnostic methods.

[d] Applicant must confirm that all sensor components are adequately stable within the operational chemical, electrochemical, and thermal environments.

[e] To be practical, the sensor must retain full functionality longer than the cell; preferably the sensor, in its entirety or at least in part, can be repaired, reused, or recycled.

[f] Based on rationale that cell-level SOH data during operation can be leveraged to modulate operating parameters, thereby extending cycle life.

II. AWARD INFORMATION

A. AWARD OVERVIEW

ARPA-E expects to make approximately $30 million available for new awards, subject to the availability of appropriated funds. ARPA-E anticipates making approximately 10-15 awards under this FOA. ARPA-E may, at its discretion, issue one, multiple, or no awards.

ARPA-E will accept only new applications under this FOA. Applicants may not seek renewal or supplementation of their existing awards through this FOA.

ARPA-E plans to fully fund negotiated budgets at the time of award.

Applicants must apply for a Combined Phase I/II Award or a Combined Phase I/II/IIS Award. Combined Phase I/II and I/II/IIS Awards are intended to develop transformational technologies with disruptive commercial potential. Such commercial potential may be evidenced by (1) the likelihood of follow-on funding by private or non-SBIR/STTR sources if the project is successful, or (2) the Small Business Concern's record of successfully commercializing technologies developed under prior SBIR/STTR awards. Phase IIS awards are a "sequential" (i.e., additional) Phase II award, intended to allow the continued development of promising energy technologies. Combined Phase I/II/IIS awards may be funded up to $4,398,504. Funding amounts will be consistent with the Phase I and Phase II limits posted on the SBA's website.[25]

ARPA-E reserves the right to select all or part of a proposed project (i.e., only Phase I, or only Phase I and Phase II). In the event that ARPA-E selects Phase I only or Phase I/II only, then the maximum award amount for a Phase I award is $306,872 and the maximum amount for a Phase I/II award is $2,352,688.

The period of performance for funding agreements may not exceed 36 months for a Combined Phase I/II/IIS Award. ARPA-E expects to issue funding agreements in December 2024, or as negotiated.

B. RENEWAL AWARDS

At ARPA-E's sole discretion, awards resulting from this FOA may be renewed by adding one or more budget periods, extending the period of performance of the initial award, or issuing a new award. Renewal funding is contingent on: (1) availability of funds appropriated by Congress for the purpose of this program; (2) substantial progress towards meeting the objectives of the approved application; (3) submittal of required reports; (4) compliance with the terms and

[25] For current SBIR Phase I and Phase II funding amounts, see https://www.sbir.gov/about/about-sbir. For current STTR Phase I and Phase II funding amounts, see https://www.sbir.gov/about/about-sttr. Phase IIS funding amounts are equal to Phase II funding amounts for both SBIR and STTR awards.

conditions of the award; (5) ARPA-E approval of a renewal application; and (6) other factors identified by the Agency at the time it solicits a renewal application.

C. ARPA-E FUNDING AGREEMENTS

Through cooperative agreements, other transactions, and similar agreements, ARPA-E provides financial and other support to projects that have the potential to realize ARPA-E's statutory mission. ARPA-E does not use such agreements to acquire property or services for the direct benefit or use of the U.S. Government.

Congress directed ARPA-E to "establish and monitor project milestones, initiate research projects quickly, and just as quickly terminate or restructure projects if such milestones are not achieved."[26] Accordingly, ARPA-E has substantial involvement in the direction of every Cooperative Agreement, as described in Section II.C below.

Cooperative Agreements involve the provision of financial or other support to accomplish a public purpose of support or stimulation authorized by Federal statute. Under Cooperative Agreements, the Government and Prime Recipients share responsibility for the direction of projects.

Phase I will be made as a fixed-amount award. Phase II and Phase IIS of Combined Phase I/II/IIS awards will be made on a cost-reimbursement basis.

ARPA-E encourages Prime Recipients to review the Model Cooperative Agreement, which is available at https://arpa-e.energy.gov/technologies/project-guidance/pre-award-guidance/funding-agreements.

D. STATEMENT OF SUBSTANTIAL INVOLVEMENT

ARPA-E is substantially involved in the direction of projects from inception to completion. For the purposes of an ARPA-E project, substantial involvement means:

- Project Teams must adhere to ARPA-E's agency-specific and programmatic requirements.
- ARPA-E may intervene at any time in the conduct or performance of work under an award.
- ARPA-E does not limit its involvement to the administrative requirements of an award. Instead, ARPA-E has substantial involvement in the direction and redirection of the technical aspects of the project as a whole.
- ARPA-E may, at its sole discretion, modify or terminate projects that fail to achieve predetermined Go/No Go decision points or technical milestones and deliverables.

[26] U.S. Congress, Conference Report to accompany the 21st Century Competitiveness Act of 2007, H. Rpt. 110-289 at 171-172 (Aug. 1, 2007).

- During award negotiations, ARPA-E Program Directors and Prime Recipients mutually establish an aggressive schedule of quantitative milestones and deliverables that must be met every quarter. In addition, ARPA-E will negotiate and establish "Go/No-Go" milestones for each project. If the Prime Recipient fails to achieve any of the "Go/No-Go" milestones or technical milestones and deliverables as determined by the ARPA-E Contracting Officer, ARPA-E may – at its discretion - renegotiate the statement of project objectives or schedule of technical milestones and deliverables for the project. In the alternative, ARPA-E may suspend or terminate the award in accordance with 2 C.F.R. §§ 200.339 – 200.343.
- ARPA-E may provide guidance and/or assistance to the Prime Recipient to accelerate the commercialization of ARPA-E-funded technologies. Guidance and assistance provided by ARPA-E may include coordination with other Government agencies and nonprofits[27] to provide mentoring and networking opportunities for Prime Recipients. ARPA-E may also organize and sponsor events to educate Prime Recipients about key barriers to the commercialization of their ARPA-E-funded technologies. In addition, ARPA-E may establish collaborations with private and public entities to provide continued support for the development and commercialization of ARPA-E-funded technologies.

[27] The term "nonprofit organization" or "nonprofit" is defined in Section IX.

III. ELIGIBILITY INFORMATION

A. ELIGIBLE APPLICANTS

1. SBIR ELIGIBILITY

SBA rules and guidelines govern eligibility to apply to this FOA. For information on program eligibility, please refer to the SBIR/STTR website, available at https://www.sbir.gov, and to the "Eligibility" section for SBIR/STTR programs at https://www.sbir.gov/about.

A Small Business Concern[28] may apply as a Standalone Applicant[29] or as the lead organization for a Project Team.[30] If applying as the lead organization, the Small Business Concern must perform at least 66.7% of the work in Phase I and at least 50% of the work in Phase II and Phase IIS, as measured by the Total Project Cost.[31]

For information on eligibility as a Small Business Concern, please refer to SBA's SBIR/STTR Program's website (https://www.sbir.gov/about).

2. STTR ELIGIBILITY

SBA rules and guidelines govern eligibility to apply to this FOA. For information on program eligibility, please refer the SBIR/STTR website, available at https://www.sbir.gov, and to the "Eligibility" section for SBIR/STTR programs at https://www.sbir.gov/about.

Only a Small Business Concern may apply as the lead organization for a Project Team. The Small Business Concern must perform at least 40% of the work in Phase I, Phase II, and/or Phase IIS, as measured by the Total Project Cost. A single Research Institution must perform at least 30% of the work in Phase I, Phase II, and/or Phase IIS, as measured by the Total Project Cost. Please

[28] A Small Business Concern is a for-profit entity that: (1) maintains a place of business located in the United States; (2) operates primarily within the United States or makes a significant contribution to the United States economy through payment of taxes or use of American products, materials or labor; (3) is an individual proprietorship, partnership, corporation, limited liability company, joint venture, association, trust, or cooperative; and (4) meets the size eligibility requirements set forth in 13 C.F.R. § 121.702. Where the entity is formed as a joint venture, there can be no more than 49% participation by foreign business entities in the joint venture. Small Business Concerns that are majority-owned by multiple venture capital operating companies, hedge funds, or private equity firms are eligible to apply to this FOA.

[29] A "Standalone Applicant" is an Applicant that applies for funding on its own, not as part of a Project Team.

[30] The term "Project Team" is used to mean any entity with multiple players working collaboratively and could encompass anything from an existing organization to an ad hoc teaming arrangement. A Project Team consists of the Prime Recipient, Subrecipients, and others performing any of the research and development work under an ARPA-E funding agreement, whether or not costs of performing the research and development work are being reimbursed under any agreement.

[31] The Total Project Cost is the sum of the Prime Recipient share and the Federal Government share of total allowable costs. The Federal Government share generally includes costs incurred by GOGOs, FFRDCs, and GOCOs.

refer to Section III.B.1 of the FOA for guidance on Research Institutions' participation in STTR projects.

For information on eligibility as a Small Business Concern, please refer to SBA's SBIR/STTR Program's website (https://www.sbir.gov/about).

3. JOINT SBIR AND STTR ELIGIBILITY

An Applicant that meets both the SBIR and STTR eligibility criteria above may request both SBIR and STTR funding if:

- The Small Business Concern is partnered with a Research Institution;
- The Small Business Concern performs at least 66.7% of the work in Phase I and at least 50% of the work in Phase II and/or Phase IIS (as applicable), as measured by the Total Project Cost;
- The partnering Research Institution performs 30-33.3% of the work in Phase I and 30-50% of the work in Phase II and/or Phase IIS (as applicable), as measured by the Total Project Cost; and
- The Principal Investigator (PI) is employed by the Small Business Concern. If the PI is employed by the Research Institution, submissions will be considered only under the STTR program.

B. ELIGIBLE SUBRECIPIENTS

1. RESEARCH INSTITUTIONS

A Research Institution[32] may apply only as a member of a Project Team (i.e., as a Subrecipient to a Small Business Concern). In STTR projects, a single Research Institution must perform at least 30%, but no more than 60%, of the work under the award in Phase I, Phase II, and/or Phase IIS (as applicable), as measured by the Total Project Cost.

2. OTHER PROJECT TEAM MEMBERS

The following entities are eligible to apply for SBIR/STTR funding as a member of a Project Team (i.e., as a Subrecipient to a Small Business Concern):

- For-profit entities, including Small Business Concerns

[32] Research Institutions include FFRDCs, nonprofit educational institutions, and other nonprofit research organizations owned and operated exclusively for scientific purposes. Eligible Research Institutions must maintain a place of business in the United States, operate primarily in the United States, or make a significant contribution to the U.S. economy through the payment of taxes or use of American products, materials, or labor.

- Nonprofits other than Research Institutions[33]
- Government-Owned, Government Operated laboratories (GOGOs)
- State, local, and tribal government entities
- Foreign entities[34]

In SBIR projects, Project Team members other than the lead organization, including but not limited to Research Institutions, may collectively perform no more than 33.3% of the work under the award in Phase I and no more than 50% of the work under the award in Phase II and/or Phase IIS. This includes efforts performed by Research Institutions.

In STTR projects, Project Team members (other than the lead organization and the partnering Research Institution) may collectively perform no more than 30% of work under the award in Phase I, Phase II, and/or Phase IIS.

C. ELIGIBLE PRINCIPAL INVESTIGATORS

1. SBIR

For the duration of the award, the PI for the proposed project (or, if multiple PIs, at least one PI) must be employed by, and perform more than 50% of his or her work for, the Prime Recipient. The Contracting Officer may waive this requirement or approve the substitution of the PI after consultation with the ARPA-E SBIR/STTR Program Director.

For projects with multiple PIs, at least one PI must meet the primary employment requirement. That PI will serve as the contact PI for the Project Team.

2. STTR

For the duration of the award, the PI for the proposed project (or, if multiple PIs, at least one PI) must be employed by, and perform more than 50% his or her work for, the Prime Recipient or the partnering Research Institution. The Contracting Officer may waive this requirement or approve the substitution of the PI after consultation with the ARPA-E SBIR/STTR Program Director.

For projects with multiple PIs, at least one PI must meet the primary employment requirement. That PI will serve as the contact PI for the Project Team.

[33]Nonprofit organizations described in section 501(c)(4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 1995 are not eligible to apply for funding as a Subrecipient.
[34] All work by foreign entities must be performed by subsidiaries or affiliates incorporated in the United States (see Section IV.G.6 of the FOA). However, the Applicant may request a waiver of this requirement in the Business Assurances & Disclosures Form submitted with the Full Application.

D. ELIGIBILITY OF PRIOR SBIR AND STTR AWARDEES: SBA BENCHMARKS ON PROGRESS TOWARDS COMMERCIALIZATION

Applicants awarded multiple prior SBIR or STTR awards must meet DOE's benchmark requirements for progress towards commercialization before ARPA-E may issue a new Phase I award. For purposes of this requirement, Applicants are assessed using their prior Phase I and Phase II SBIR and STTR awards across all SBIR agencies. If an awardee fails to meet either of the benchmarks, that awardee is not eligible for an SBIR or STTR Phase I award and any Phase II award for a period of one year from the time of the determination.

ARPA-E applies two benchmark rates addressing an Applicant's progress towards commercialization: (1) the DOE Phase II Transition Rate Benchmark and (2) the SBA Commercialization Rate Benchmark:

- The DOE Phase II Transition Rate Benchmark sets the minimum required number of Phase II awards the Applicant must have received for a given number of Phase I awards received during the specified period. **This Transition Rate Benchmark applies only to Phase I Applicants that have received more than 20 Phase I awards during the last five (5) year period, excluding the most recently completed fiscal year**. DOE's Phase II Transition Rate Benchmark requires that 25% of all Phase I awards received over the past five years transition to Phase II awards.

  The SBIR/STTR Phase II transition rates and commercialization rates are calculated using the data in the SBA's TechNet database. For the purpose of these benchmark requirements, awardee firms are assessed once a year, on June 1st, using their prior SBIR and STTR awards across all agencies. SBA makes this tabulation of awardee transition rates and commercialization rates available to all federal agencies. ARPA-E uses this tabulation to determine which companies do not meet the DOE benchmark rates and are, therefore, ineligible to receive new Phase I awards.

- The Commercialization Rate Benchmark sets the minimum Phase III[35] commercialization results that an Applicant must have achieved from work it performed under prior Phase II awards (i.e., this measures an Applicant's progress from Phase II or Phase IIS to Phase III awards). **This benchmark requirement applies only to Applicants that have received more than 15 Phase II awards during the last 10 fiscal years, excluding the two most recently completed fiscal years.**

[35] Phase III refers to work that derives from, extends or completes an effort made under prior SBIR/STTR funding agreements, but is funded by sources other than the SBIR/STTR Program. Phase III work is typically oriented towards commercialization of SBIR/STTR research or technology. For more information please refer to the Small Business Administration's "Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Program Program Policy Directive" at https://www.sbir.gov/sites/default/files/SBIR-STTR_Policy_Directive_2019.pdf.

The current Commercialization Benchmark requirement, agreed upon and established by all 11 SBIR agencies, is that the Applicants must have received, to date, an average of at least $100,000 of sales and/or investments per Phase II award received, or have received a number of patents resulting from the relevant SBIR/STTR work equal to or greater than 15% of the number of Phase II awards received during the period.

- On June 1 of each year, SBIR/STTR awardees registered on SBIR.gov are assessed to determine if they meet the Phase II Transition Rate Benchmark requirement. (At this time, SBA is not identifying companies that fail to meet the Commercialization Rate Benchmark requirement). Companies that fail to meet the Phase II Transition Rate Benchmark as of June 1 of a given year will not be eligible to apply to an SBIR/STTR FOA for the following year. For example, if SBA determined on June 1, 2017, that a small business failed to meet the Phase II Transition Rate Benchmark requirement, that small business would not be eligible to apply to an ARPA-E SBIR/STTR FOA from June 1, 2017, to May 31, 2018.

E. COST SHARING

Cost sharing is not required for this FOA.

F. OTHER

1. COMPLIANT CRITERIA

Concept Papers are deemed compliant if:

- The Applicant meets the eligibility requirements in Section III.A of the FOA;
- The Concept Paper complies with the content and form requirements in Section IV.C of the FOA; and
- The Applicant entered all required information, successfully uploaded all required documents, and clicked the "Submit" button in ARPA-E eXCHANGE by the deadline stated in the FOA.

Concept Papers found to be noncompliant may not be merit reviewed or considered for award. ARPA-E may not review or consider noncompliant Concept Papers, including Concept Papers submitted through other means, Concept Papers submitted after the applicable deadline, and incomplete Concept Papers. A Concept Paper is incomplete if it does not include required information. ARPA-E will not extend the submission deadline for Applicants that fail to submit required information and documents due to server/connection congestion.

Full Applications are deemed compliant if:

- The Applicant submitted a compliant and responsive Concept Paper;

- The Applicant meets the eligibility requirements in Section III.A of the FOA;
- The Full Application complies with the content and form requirements in Section IV.D of the FOA; and
- The Applicant entered all required information, successfully uploaded all required documents, and clicked the "Submit" button in ARPA-E eXCHANGE by the deadline stated in the FOA.

Full Applications found to be noncompliant may not be merit reviewed or considered for award. ARPA-E may not review or consider noncompliant Full Applications, including Full Applications submitted through other means, Full Applications submitted after the applicable deadline, and incomplete Full Applications. A Full Application is incomplete if it does not include required information and documents, such as Forms SF-424 and SF-424A. ARPA-E will not extend the submission deadline for Applicants that fail to submit required information and documents due to server/connection congestion.

Replies to Reviewer Comments are deemed compliant if:

- The Applicant successfully uploads its response to ARPA-E eXCHANGE by the deadline stated in the FOA; and
- The Replies to Reviewer Comments comply with the content and form requirements of Section IV.E of the FOA.

ARPA-E will not review or consider noncompliant Replies to Reviewer Comments, including Replies submitted through other means and Replies submitted after the applicable deadline. ARPA-E will not extend the submission deadline for Applicants that fail to submit required information due to server/connection congestion. ARPA-E will review and consider each compliant and responsive Full Application, even if no Reply is submitted or if the Reply is found to be noncompliant.

2. RESPONSIVENESS CRITERIA

ARPA-E performs a preliminary technical review of Concept Papers and Full Applications. The following types of submissions may be deemed nonresponsive and may not be reviewed or considered:

- Submissions that fall outside the technical parameters specified in this FOA.
- Submissions that have been submitted in response to currently issued ARPA-E FOAs.
- Submissions that are not scientifically distinct from applications submitted in response to currently issued ARPA-E FOAs.
- Submissions for basic research aimed solely at discovery and/or fundamental knowledge generation.
- Submissions for large-scale demonstration projects of existing technologies.

- Submissions for proposed technologies that represent incremental improvements to existing technologies.
- Submissions for proposed technologies that are not based on sound scientific principles (e.g., violates a law of thermodynamics).
- Submissions for proposed technologies that are not transformational, as described in Section I.A of the FOA.
- Submissions for proposed technologies that do not have the potential to become disruptive in nature, as described in Section I.A of the FOA. Technologies must be scalable such that they could be disruptive with sufficient technical progress.
- Submissions that are not distinct in scientific approach or objective from activities currently supported by or actively under consideration for funding by any other office within Department of Energy.
- Submissions that are not distinct in scientific approach or objective from activities currently supported by or actively under consideration for funding by other government agencies or the private sector.
- Submissions that do not propose a R&D plan that allows ARPA-E to evaluate the submission under the applicable merit review criteria provided in Section V.A of the FOA.
- Submissions that do not propose a Combined Phase I/II/IIS Award, as described in Section II.A of the FOA.
- Submissions that propose using funding for construction, alteration, maintenance, or repair of public infrastructure in the United States.

3. SUBMISSIONS SPECIFICALLY NOT OF INTEREST

Submissions that propose the following will be deemed nonresponsive and will not be merit reviewed or considered:

Submissions that propose the following will be deemed nonresponsive and may not be merit reviewed or considered:

- Concepts that focus on supplying critical minerals for battery fabrication.
- Curiosity-driven discovery of new battery materials.
- Concepts that focus on conventional lead-acid batteries.
- Concepts that focus on existing battery recycling processes, including direct recycling.
- Solutions that focus on incremental improvements in commercial technologies, incremental improvements in control systems for commercial technologies, or incremental improvements in operation or maintenance procedures.

4. LIMITATION ON NUMBER OF SUBMISSIONS

ARPA-E is not limiting the number of submissions from Applicants. Applicants may submit more than one application to this FOA, provided that each application is scientifically distinct.

Small business Applicants that qualify as a "Small Business Concern" may apply to only one of the two ARPA-E CIRCULAR FOAs: DE-FOA-0003324 (CIRCULAR SBIR/STTR), or DE-FOA-0003303 (CIRCULAR). Small businesses that qualify as "Small Business Concerns" are strongly encouraged to apply under the former (SBIR/STTR FOA). To determine eligibility as a "Small Business Concern" under DE-FOA-0003324, please review the eligibility requirements in Sections III.A – III.D above.

IV. APPLICATION AND SUBMISSION INFORMATION

A. APPLICATION PROCESS OVERVIEW

1. REGISTRATION IN SBA COMPANY REGISTRY

The first step in applying to this FOA is registering in the U.S. Small Business Administration (SBA) Company Registry (http://sbir.gov/registration). Upon completing registration, Applicants will receive a unique small business Control ID and Registration Certificate in Adobe PDF format, which may be used at any participating SBIR and STTR agencies. Applicants that have previously registered in the SBA Company Registry need not register again.

Applicants must submit their Registration Certificate in ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov) as part of their Full Application (see Section IV.D.6 of the FOA).

2. REGISTRATION IN ARPA-E eXCHANGE

The second step in applying to this FOA is registration in ARPA-E eXCHANGE, ARPA-E's online application portal. For detailed guidance on using ARPA-E eXCHANGE, please refer to Section IV.H.1 of the FOA and the "ARPA-E eXCHANGE User Guide" (https://arpa-e-foa.energy.gov/Manuals.aspx).

3. CONCEPT PAPERS

Applicants must submit a Concept Paper by the deadline stated in the FOA. Section IV.C of the FOA provides instructions on submitting a Concept Paper.

ARPA-E performs a preliminary review of Concept Papers to determine whether they are compliant and responsive, as described in Section III.F of the FOA. Concept Papers found to be noncompliant or nonresponsive may not be merit reviewed or considered for award. ARPA-E makes an independent assessment of each compliant and responsive Concept Paper based on the criteria and program policy factors in Sections V.A.1 and V.B.1 of the FOA.

ARPA-E will encourage a subset of Applicants to submit Full Applications. Other Applicants will be discouraged from submitting a Full Application in order to save them the time and expense of preparing an application submission that is unlikely to be selected for award negotiations. By discouraging the submission of a Full Application, ARPA-E intends to convey its lack of programmatic interest in the proposed project. Such assessments do not necessarily reflect judgments on the merits of the proposed project. Unsuccessful Applicants should continue to submit innovative ideas and concepts to future FOAs.

4. FULL APPLICATIONS

Applicants must submit a Full Application by the deadline stated in the FOA. Applicants will have approximately 45 days from receipt of the Encourage/Discourage notification to prepare and submit a Full Application. Section IV.D of the FOA provides instructions on submitting a Full Application.

ARPA-E performs a preliminary review of Full Applications to determine whether they are compliant and responsive, as described in Section III.F of the FOA. Full Applications found to be noncompliant or nonresponsive may not be merit reviewed or considered for award. ARPA-E makes an independent assessment of each compliant and responsive Full Application based on the criteria and program policy factors in Sections V.A.2 and V.B.1 of the FOA.

5. REPLY TO REVIEWER COMMENTS

Once ARPA-E has completed its review of Full Applications, reviewer comments on compliant and responsive Full Applications are made available to Applicants via ARPA-E eXCHANGE. Applicants may submit an optional Reply to Reviewer Comments, which must be submitted by the deadline stated in the FOA. Section IV.E of the FOA provides instructions on submitting a Reply to Reviewer Comments.

ARPA-E performs a preliminary review of Replies to determine whether they are compliant, as described in Section III.F.1 of the FOA. ARPA-E will review and consider compliant Replies only. ARPA-E will review and consider each compliant and responsive Full Application, even if no Reply is submitted or if the Reply is found to be non-compliant.

6. PRE-SELECTION CLARIFICATIONS AND "DOWN-SELECT" PROCESS

Once ARPA-E completes its review of Full Applications and Replies to Reviewer Comments, it may, at the Contracting Officer's discretion, conduct a pre-selection clarification process and/or perform a "down-select" of Full Applications. Through the pre-selection clarification process or down-select process, ARPA-E may obtain additional information from select Applicants through pre-selection meetings, webinars, videoconferences, conference calls, written correspondence, or site visits that can be used to make a final selection determination. ARPA-E will not reimburse Applicants for travel and other expenses relating to pre-selection meetings or site visits, nor will these costs be eligible for reimbursement as pre-award costs.

ARPA-E may select applications for award negotiations and make awards without pre-selection meetings and site visits. Participation in a pre-selection meeting or site visit with ARPA-E does not signify that Applicants have been selected for award negotiations.

7. SELECTION FOR AWARD NEGOTIATIONS

ARPA-E carefully considers all of the information obtained through the application process and makes an independent assessment of each compliant and responsive Full Application based on the criteria and program policy factors in Sections V.A.2 and V.B.1 and the risk analysis in Section VI.B.8 of the FOA. The Selection Official may select all or part of a Full Application for award negotiations. The Selection Official may also postpone a final selection determination on one or more Full Applications until a later date, subject to availability of funds and other factors. ARPA-E will enter into award negotiations only with selected Applicants.

Applicants are promptly notified of ARPA-E's selection determination. ARPA-E may stagger its selection determinations. As a result, some Applicants may receive their notification letter in advance of other Applicants. Please refer to Section VI.A of the FOA for guidance on award notifications.

B. APPLICATION FORMS

Required forms for Full Applications are available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov), including the SF-424 and Budget Justification Workbook/SF-424A. A sample Summary Slide is available on ARPA-E eXCHANGE. Applicants may use the templates available on ARPA-E eXCHANGE, including the template for the Concept Paper, the template for the Technical Volume of the Full Application, the template for the Summary Slide, the template for the Summary for Public Release, the template for the Reply to Reviewer Comments, and the template for the Business Assurances & Disclosures Form. A sample response to the Business Assurances & Disclosures Form is available on ARPA-E eXCHANGE.

C. CONTENT AND FORM OF CONCEPT PAPERS

The Concept Paper is mandatory (i.e., in order to submit a Full Application, a compliant and responsive Concept Paper must have been submitted) and must conform to the following formatting requirements:

- The Concept Paper must not exceed 4 pages in length including graphics, figures, and/or tables.
- The Concept Paper must be submitted in Adobe PDF format.
- The Concept Paper must be written in English.
- All pages must be formatted to fit on 8-1/2 by 11-inch paper with margins not less than one inch on every side. Single space all text and use Times New Roman typeface, a black font color, and a font size of 12 point or larger (except in figures and tables).
- The ARPA-E assigned Control Number, the Lead Organization Name, and the Principal Investigator's Last Name must be prominently displayed on the upper right

corner of the header of every page. Page numbers must be included in the footer of every page.

- The first paragraph must include the Lead Organization's Name and Location, Principal Investigator's Name, Technical Category, Proposed Funding Requested (Federal and Cost Share [not required for this SBIR/STTR FOA]), and Project Duration.

Concept Papers found to be noncompliant or nonresponsive may not be merit reviewed or considered for award (see Section III.F of the FOA).

Each Concept Paper must be limited to a single concept or technology. Unrelated concepts and technologies must not be consolidated into a single Concept Paper.

A fillable Concept Paper template is available on ARPA-E eXCHANGE at https://arpa-e-foa.energy.gov.

Concept Papers must conform to the content requirements described below. If Applicants exceed the maximum page length indicated above, ARPA-E will review only the authorized number of pages and disregard any additional pages.

1. CONCEPT PAPER

a. CONCEPT SUMMARY

- Describe the proposed concept with minimal jargon and explain how it addresses the Program Objectives of the FOA.

b. INNOVATION AND IMPACT

- Clearly identify the problem to be solved with the proposed technology concept.
- Describe how the proposed effort represents an innovative and potentially transformational solution to the technical challenges posed by the FOA.
- Explain the concept's potential to be disruptive compared to existing or emerging technologies.
- To the extent possible, provide quantitative metrics in a table that compares the proposed technology concept to current and emerging technologies and to the Technical Performance Targets in Section I.E of the FOA for the appropriate Technology Category in Section I.D of the FOA.

c. PROPOSED WORK

- Describe the final deliverable(s) for the project and the overall technical approach used to achieve project objectives.

- Discuss alternative approaches considered, if any, and why the proposed approach is most appropriate for the project objectives.
- Describe the background, theory, simulation, modeling, experimental data, or other sound engineering and scientific practices or principles that support the proposed approach. Provide specific examples of supporting data and/or appropriate citations to the scientific and technical literature.
- Describe why the proposed effort is a significant technical challenge and the key technical risks to the project. Does the approach require one or more entirely new technical developments to succeed? How will technical risk be mitigated?
- Identify techno-economic challenges to be overcome for the proposed technology to be commercially relevant.
- Estimated federal funds requested; total project cost including cost share (if cost share is being provided – cost share is not required under this FOA).

d. TEAM ORGANIZATION AND CAPABILITIES

- Indicate the roles and responsibilities of the organizations and key personnel that comprise the Project Team.
- Provide the name, position, and institution of each key team member and describe in 1-2 sentences the skills and experience that he/she brings to the team.
- Identify key capabilities provided by the organizations comprising the Project Team and how those key capabilities will be used in the proposed effort.
- Identify (if applicable) previous collaborative efforts among team members relevant to the proposed effort.

D. CONTENT AND FORM OF FULL APPLICATIONS

[TO BE INSERTED BY FOA MODIFICATION IN MAY 2024]

E. CONTENT AND FORM OF REPLIES TO REVIEWER COMMENTS

[TO BE INSERTED BY FOA MODIFICATION IN MAY 2024]

F. INTERGOVERNMENTAL REVIEW

This program is not subject to Executive Order 12372 (Intergovernmental Review of Federal Programs).

G. FUNDING RESTRICTIONS

1. ALLOWABLE COSTS

All expenditures must be allowable, allocable, and reasonable in accordance with the applicable Federal cost principles. Pursuant to 2 C.F.R. § 910.352, the cost principles in the Federal

Acquisition Regulations (48 C.F.R. Part 31.2) apply to for-profit entities. The cost principles contained in 2 C.F.R. Part 200; Subpart E apply to all entities other than for-profits.

2. PRE-AWARD COSTS

ARPA-E will not reimburse any pre-award costs incurred by Applicants before they are selected for award negotiations. Please refer to Section VI.A of the FOA for guidance on award notices.

Upon selection for award negotiations, Applicants may incur pre-award costs at their own risk, consistent with the requirements in 2 C.F.R. Part 200, as modified by 2 C.F.R. Part 910, and other Federal laws and regulations. All submitted budgets are subject to change and are typically reworked during award negotiations. ARPA-E is under no obligation to reimburse pre-award costs if, for any reason, the Applicant does not receive an award or the award is made for a lesser amount than the Applicant expected, or if the costs incurred are not allowable, allocable, or reasonable.

3. PATENT COSTS

For Subject Inventions disclosed to DOE under an award, ARPA-E will reimburse the Prime Recipient – in addition to allowable costs associated with Subject Invention disclosures - up to $30,000 of expenditures for filing and prosecution of United States patent applications, including international applications (PCT application) submitted to the United States Patent and Trademark Office (USPTO).

The Prime Recipient may request a waiver of the $30,000 cap. Note that, patent costs are considered to be Technology Transfer & Outreach (TT&O) costs (see Section IV.G.8 of the FOA below) and should be requested as such.

4. CONSTRUCTION

ARPA-E generally does not fund projects that involve major construction. Recipients are required to obtain written authorization from the Contracting Officer before incurring any major construction costs.

5. FOREIGN TRAVEL

ARPA-E generally does not fund projects that involve foreign travel. Recipients are required to obtain written authorization from the ARPA-E Program Director before incurring any foreign travel costs and provide trip reports with their reimbursement requests.

6. PERFORMANCE OF WORK IN THE UNITED STATES

ARPA-E strongly encourages interdisciplinary and cross-sectoral collaboration spanning

organizational boundaries. Such collaboration enables the achievement of scientific and technological outcomes that were previously viewed as extremely difficult, if not impossible.

ARPA-E requires all work under ARPA-E funding agreements to be performed in the United States – i.e., Prime Recipients must expend 100% of the Total Project Cost in the United States. However, Applicants may request a waiver of this requirement where their project would materially benefit from, or otherwise requires, certain work to be performed overseas.

Applicants seeking a waiver of this requirement are required to include an explicit request in the Business Assurances & Disclosures Form, which is part of the Full Application submitted to ARPA-E. Such waivers are granted where there is a demonstrated need, as determined by ARPA-E.

7. PURCHASE OF NEW EQUIPMENT

All equipment purchased under ARPA-E funding agreements must be made or manufactured in the United States, to the maximum extent practicable. This requirement does not apply to used or leased equipment. The Prime Recipients are required to notify the ARPA-E Contracting Officer reasonably in advance of purchasing any equipment that is not made or manufactured in the United States with a total acquisition cost of $250,000 or more. Purchases of foreign equipment with a total acquisition cost of $1,000,000 or more require the approval of the Head of Contracting Activity (HCA). The ARPA-E Contracting Officer will provide consent to purchase or reject within 30 calendar days of receipt of the Recipient's notification.

8. TECHNOLOGY TRANSFER AND OUTREACH

ARPA-E is required to contribute a percentage of appropriated funds to Technology Transfer and Outreach (TT&O) activities. In order to meet this mandate, every Project Team must spend at least 5% of the Federal funding (i.e., the portion of the award that does not include the recipient's cost share) provided by ARPA-E on TT&O activities to promote and further the development and eventual deployment of ARPA-E-funded technologies. Project Teams must also seek a waiver from ARPA-E to spend less than the minimum 5% TT&O expenditure requirement.

All TT&O expenditures are subject to the applicable Federal cost principles (i.e., 2 C.F.R. 200 Subpart E and 48 C.F.R. Subpart 31). Examples of TT&O expenditures are as follows:

- Documented travel and registration for the ARPA-E Energy Innovation Summit and other energy-related conferences and events;
- Documented travel to meet with potential suppliers, partners, or customers;
- Documented work by salaried or contract personnel to develop technology-to-market models or plans;
- Documented costs of acquiring industry-accepted market research reports; and

- Approved patent costs.

ARPA-E will not reimburse recipients for TT&O costs considered to be unallowable in accordance with the applicable cost principles. Examples of unallowable TT&O expenditures include:

- Meals or entertainment;
- Gifts to potential suppliers, partners, or customers;
- TT&O activities that do not relate to the ARPA-E-funded technologies;
- Undocumented TT&O activities; and
- TT&O activities unrelated and/or unallocable to the subject award.

Applicants may seek a waiver of the TT&O requirement by including an explicit request in the Business Assurances & Disclosures Form. Please refer to the Business Assurances & Disclosures Form for guidance on the content and form of the waiver request. ARPA-E may waive or modify the TT&O requirement, as appropriate.

For information regarding incorporation of TT&O costs into budget documentation, see Section IV.D.3 of the FOA.

9. LOBBYING

Prime Recipients and Subrecipients may not use any Federal funds, directly or indirectly, to influence or attempt to influence, directly or indirectly, congressional action on any legislative or appropriation matters pending before Congress, other than to communicate to Members of Congress as described in 18 U.S.C. § 1913. This restriction is in addition to those prescribed elsewhere in statute and regulation.

Prime Recipients and Subrecipients are required to complete and submit SF-LLL, "Disclosure of Lobbying Activities" (https://www.gsa.gov/forms-library/disclosure-lobbying-activities) if any non-Federal funds have been paid or will be paid to any person for influencing or attempting to influence any of the following in connection with your application:

- An officer or employee of any Federal agency,
- A Member of Congress,
- An officer or employee of Congress, or
- An employee of a Member of Congress.

10. CONFERENCE SPENDING

Prime Recipients and Subrecipients may not use any Federal funds to:

- Defray the cost to the United States Government of a conference held by any Executive branch department, agency, board, commission, or office which is not directly and programmatically related to the purpose for which their ARPA-E award is made and for which the cost to the United States Government is more than $20,000; or
- To circumvent the required notification by the head of any such Executive Branch department, agency, board, commission, or office to the Inspector General (or senior ethics official for any entity without an Inspector General), of the date, location, and number of employees attending such a conference.

11. INDEPENDENT RESEARCH AND DEVELOPMENT COSTS

ARPA-E does not fund Independent Research and Development (IR&D) as part of an indirect cost rate under its Grants and Cooperative Agreements. IR&D, as defined at FAR 31.205-18(a), includes cost of effort that is not sponsored by an assistance agreement or required in performance of a contract, and that consists of projects falling within the four following areas: (i) basic research, (ii) applied research, (iii) development, and (iv) systems and other concept formulation studies.

ARPA-E's goals are to enhance the economic and energy security of the United States through the development of energy technologies and ensure that the United States maintains a technological lead in developing and deploying advanced energy technologies. ARPA-E accomplishes these goals by providing financial assistance for energy technology projects and has well recognized and established procedures for supporting research through competitive financial assistance awards based on merit review of proposed projects. Reimbursement for independent research and development costs through the indirect cost mechanism could circumvent this competitive process.

To ensure that all projects receive similar and equal consideration, eligible organizations may compete for direct funding of independent research projects they consider worthy of support by submitting proposals for those projects to ARPA-E. Since proposals for these projects may be submitted for direct funding, costs for independent research and development projects are not allowable as indirect costs under ARPA-E awards. IR&D costs, however, would still be included in the direct cost base that is used to calculate the indirect rate so as to ensure an appropriate allocation of indirect costs to the organization's direct cost centers.

12. PROHIBITION ON CERTAIN TELECOMMUNICATIONS AND VIDEO SURVEILLANCE SERVICES OR EQUIPMENT

Per 2 C.F.R. § 200.216, recipients and subrecipients are prohibited from obligating or expending project funds to: (1) procure or obtain; (2) extend or renew a contract to procure or obtain; or (3) enter into a contract (or extend or renew a contract) to procure or obtain equipment, services, or systems that uses covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system. As described in Public Law 115–232, section 889, covered telecommunications equipment is telecommunications equipment produced by Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities). Refer to 2 C.F.R. § 200.216 for possible additional prohibitions and limitations.

13. BUY AMERICA REQUIREMENT FOR PUBLIC INFRASTRUCTURE PROJECTS

Projects funded through this FOA that are for, or contain, construction, alteration, maintenance, or repair of public infrastructure in the United States undertaken by applicable recipient types, require that:

- All iron, steel, and manufactured products used in the infrastructure project are produced in the United States; and
- All construction materials used in the infrastructure project are manufactured in the United States.

However, ARPA-E does not anticipate soliciting for or selecting projects that propose project tasks that are for, or contain, construction, alteration, maintenance, or repair of public infrastructure. If a project selected for award negotiations includes project tasks that may be subject to the Buy America Requirement, those project tasks will be removed from the project before any award is issued – i.e., no federal funding or Recipient cost share will be available for covered project tasks.

This “Buy America” requirement does not apply to an award where the Prime Recipient is a for-profit entity.

14. REQUIREMENT FOR FINANCIAL PERSONNEL

ARPA-E requires Small Business or Nonprofit applicants to identify a finance/budget professional (employee or contracted support) with an understanding of Federal contracting and/or financial assistance and cost accounting (including indirect costs, invoicing, and financial management systems) that will support the team in complying with all applicable requirements.

H. OTHER SUBMISSION REQUIREMENTS

1. USE OF ARPA-E eXCHANGE

To apply to this FOA, Applicants must register with ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/Registration.aspx). Concept Papers, Full Applications, and Replies to Reviewer Comments must be submitted through ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/login.aspx). ARPA-E will not review or consider applications submitted through other means (e.g., fax, hand delivery, email, postal mail). For detailed guidance on using ARPA-E eXCHANGE, please refer to the "ARPA-E eXCHANGE Applicant Guide" (https://arpa-e-foa.energy.gov/Manuals.aspx).

Upon creating an application submission in ARPA-E eXCHANGE, Applicants will be assigned a Control Number. If the Applicant creates more than one application submission, a different Control Number will be assigned for each application.

Once logged in to ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/login.aspx), Applicants may access their submissions by clicking the "My Submissions" link in the navigation on the left side of the page. Every application that the Applicant has submitted to ARPA-E and the corresponding Control Number is displayed on that page. If the Applicant submits more than one application to a particular FOA, a different Control Number is shown for each application.

Applicants are responsible for meeting each submission deadline in ARPA-E eXCHANGE. **Applicants are strongly encouraged to submit their applications at least 48 hours in advance of the submission deadline.** Under normal conditions (i.e., at least 48 hours in advance of the submission deadline), Applicants should allow at least 1 hour to submit a Concept Paper, or Full Application. In addition, Applicants should allow at least 15 minutes to submit a Reply to Reviewer Comments. Once the application is submitted in ARPA-E eXCHANGE, Applicants may revise or update their application until the expiration of the applicable deadline.

Applicants should not wait until the last minute to begin the submission process. During the final hours before the submission deadline, Applicants may experience server/connection congestion that prevents them from completing the necessary steps in ARPA-E eXCHANGE to submit their applications. **ARPA-E will not extend the submission deadline for Applicants that fail to submit required information and documents due to server/connection congestion.**

ARPA-E may not review or consider incomplete applications and applications received after the deadline stated in the FOA. Such applications may be deemed noncompliant (see Section III.F.1 of the FOA). The following errors could cause an application to be deemed "incomplete" and thus noncompliant:

- Failing to comply with the form and content requirements in Section IV of the FOA;

- Failing to enter required information in ARPA-E eXCHANGE;
- Failing to upload required document(s) to ARPA-E eXCHANGE;
- Failing to click the "Submit" button in ARPA-E eXCHANGE by the deadline stated in the FOA;
- Uploading the wrong document(s) or application(s) to ARPA-E eXCHANGE; and
- Uploading the same document twice but labeling it as different documents. (In the latter scenario, the Applicant failed to submit a required document.)

ARPA-E urges Applicants to carefully review their applications and to allow sufficient time for the submission of required information and documents.

V. APPLICATION REVIEW INFORMATION

A. CRITERIA

ARPA-E performs a preliminary review of Concept Papers and Full Applications to determine whether they are compliant and responsive (see Section III.F of the FOA). ARPA-E also performs a preliminary review of Replies to Reviewer Comments to determine whether they are compliant.

ARPA-E considers a mix of quantitative and qualitative criteria in determining whether to encourage the submission of a Full Application and whether to select a Full Application for award negotiations.

1. CRITERIA FOR CONCEPT PAPERS

(1) Impact of the Proposed Technology Relative to FOA Targets (50%) - This criterion involves consideration of the following:

- The potential for a transformational and disruptive (not incremental) advancement compared to existing or emerging technologies;
- Achievement of the technical performance targets defined in Section I.F of the FOA for the appropriate technology Category in Section I.E of the FOA;
- Identification of techno-economic challenges that must be overcome for the proposed technology to be commercially relevant; and
- Demonstration of awareness of competing commercial and emerging technologies and identifies how the proposed concept/technology provides significant improvement over existing solutions.

(2) *Overall Scientific and Technical Merit* (50%) - This criterion involves consideration of the following:

- The feasibility of the proposed work, as justified by appropriate background, theory, simulation, modeling, experimental data, or other sound scientific and engineering practices;
- Sufficiency of technical approach to accomplish the proposed R&D objectives, including why the proposed concept is more appropriate than alternative approaches and how technical risk will be mitigated;
- Clearly defined project outcomes and final deliverables; and
- The demonstrated capabilities of the individuals performing the project, the key capabilities of the organizations comprising the Project Team, the roles and responsibilities of each organization and (if applicable) previous collaborations among team members supporting the proposed project.

Submissions will not be evaluated against each other since they are not submitted in accordance with a common work statement.

2. CRITERIA FOR FULL APPLICATIONS

[TO BE INSERTED BY FOA MODIFICATION IN MAY 2024]

3. CRITERIA FOR REPLIES TO REVIEWER COMMENTS

[TO BE INSERTED BY FOA MODIFICATION IN MAY 2024]

B. REVIEW AND SELECTION PROCESS

1. PROGRAM POLICY FACTORS

In addition to the above criteria, ARPA-E may consider the following program policy factors in determining which Concept Papers to encourage to submit a Full Application and which Full Applications to select for award negotiations:

I. **ARPA-E Portfolio Balance**. Project balances ARPA-E portfolio in one or more of the following areas:
   a. Diversity of technical personnel in the proposed Project Team;
   b. Technological diversity;
   c. Organizational diversity;
   d. Geographic diversity;
   e. Technical or commercialization risk; or
   f. Stage of technology development.

II. **Relevance to ARPA-E Mission Advancement.** Project contributes to one or more of ARPA-E's key statutory goals:
   a. Reduction of U.S. dependence on foreign energy sources;
   b. Stimulation of U.S. manufacturing and/or software development
   c. Reduction of energy-related emissions;
   d. Increase in U.S. energy efficiency;
   e. Enhancement of U.S. economic and energy security; or
   f. Promotion of U.S. advanced energy technologies competitiveness.

III. **Synergy of Public and Private Efforts**.
   a. Avoids duplication and overlap with other publicly or privately funded projects;
   b. Promotes increased coordination with nongovernmental entities for demonstration of technologies and research applications to facilitate technology transfer; or

c. Increases unique research collaborations.

IV. **Low likelihood of other sources of funding.** High technical and/or financial uncertainty that results in the non-availability of other public, private or internal funding or resources to support the project.

V. **High Project Impact Relative to Project Cost.**

VI. **Qualified Opportunity Zone (QOZ).** Whether the entity is located in an urban and economically distressed area including a Qualified Opportunity Zone (QOZ) or the proposed project will occur in a QOZ or otherwise advance the goals of QOZ. The goals include spurring economic development and job creation in distressed communities throughout the United States. For a list or map of QOZs go to: https://www.cdfifund.gov/opportunity-zones.

2. ARPA-E Reviewers

By submitting an application to ARPA-E, Applicants consent to ARPA-E's use of Federal employees, contractors, and experts from educational institutions, nonprofits, industry, and governmental and intergovernmental entities as reviewers. ARPA-E selects reviewers based on their knowledge and understanding of the relevant field and application, their experience and skills, and their ability to provide constructive feedback on applications.

ARPA-E requires all reviewers to complete a Conflict-of-Interest Certification and Nondisclosure Agreement through which they disclose their knowledge of any actual or apparent conflicts and agree to safeguard confidential information contained in Concept Papers, Full Applications, and Replies to Reviewer Comments. In addition, ARPA-E trains its reviewers in proper evaluation techniques and procedures.

Applicants are not permitted to nominate reviewers for their applications. Applicants may contact the Contracting Officer by email (ARPA-E-CO@hq.doe.gov) if they have knowledge of a potential conflict of interest or a reasonable belief that a potential conflict exists.

3. ARPA-E Support Contractors

ARPA-E utilizes contractors to assist with the evaluation of applications and project management. To avoid actual and apparent conflicts of interest, ARPA-E prohibits its support contractors from submitting or participating in the preparation of applications to ARPA-E.

By submitting an application to ARPA-E, Applicants represent that they are not performing support contractor services for ARPA-E in any capacity and did not obtain the assistance of ARPA-E's support contractor to prepare the application. ARPA-E will not consider any applications that are submitted by or prepared with the assistance of its support contractors.

C. ANTICIPATED ANNOUNCEMENT AND AWARD DATES

[TO BE INSERTED BY FOA MODIFICATION IN MAY 2024]

VI. AWARD ADMINISTRATION INFORMATION

A. AWARD NOTICES

1. REJECTED SUBMISSIONS

Noncompliant and nonresponsive Concept Papers and Full Applications are rejected by the Contracting Officer and are not merit reviewed or considered for award. The Contracting Officer sends a notification letter by email to the technical and administrative points of contact designated by the Applicant in ARPA-E eXCHANGE. The notification letter states the basis upon which the Concept Paper or Full Application was rejected.

2. CONCEPT PAPER NOTIFICATIONS

ARPA-E promptly notifies Applicants of its determination to encourage or discourage the submission of a Full Application. ARPA-E sends a notification letter by email to the technical and administrative points of contact designated by the Applicant in ARPA-E eXCHANGE. ARPA-E provides feedback in the notification letter in order to guide further development of the proposed technology.

Applicants may submit a Full Application even if they receive a notification discouraging them from doing so. By discouraging the submission of a Full Application, ARPA-E intends to convey its lack of programmatic interest in the proposed project. Such assessments do not necessarily reflect judgments on the merits of the proposed project. The purpose of the Concept Paper phase is to save Applicants the considerable time and expense of preparing a Full Application that is unlikely to be selected for award negotiations.

A notification letter encouraging the submission of a Full Application does not authorize the Applicant to commence performance of the project. Please refer to Section IV.G of the FOA for guidance on pre-award costs.

3. FULL APPLICATION NOTIFICATIONS

[TO BE INSERTED BY FOA MODIFICATION IN MAY 2024]

B. ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS

The following administrative and national policy requirements apply to Prime Recipients. The Prime Recipient is the responsible authority regarding the settlement and satisfaction of all contractual and administrative issues, including but not limited to disputes and claims arising out of any agreement between the Prime Recipient and a FFRDC contractor. Prime Recipients

are required to flow down these requirements to their Subrecipients through subawards or related agreements.

- If a subaward is made to a DOE/NNSA National Laboratory, all Disputes and Claims will be resolved in accordance with the terms and conditions of the DOE/NNSA National Laboratory's management and operating (M&O) contract, as applicable, in consultation between DOE and the prime awardee.
- If a subaward is made to another Federal agency or its FFRDC contractor, all Disputes and Claims will be resolved in accordance with the terms and conditions of the interagency agreement in consultation between DOE and the prime awardee.

1. UNIQUE ENTITY IDENTIFIER- AND SAM, FSRS, AND FEDCONNECT REGISTRATIONS

Prime Recipients must register with the System for Award Management (SAM) at www.sam.gov/SAM prior to submitting an application, at which time the system will assign (if newly registered) a Unique Entity Identifier (UEI).

Prime Recipients must:

- Maintain an active SAM registration with current information, including information on a its immediate and highest-level owner and subsidiaries, as well as on all predecessors that have been awarded a Federal contract or financial assistance award within the last three years, if applicable, at all times during which it has an active Federal award or an application or plan under consideration by a Federal awarding agency;
- Remain registered in the SAM database after the initial registration;
- Update its information in the SAM database as soon as it changes;
- Review its information in the SAM database on an annual basis from the date of initial registration or subsequent updates to ensure it is current, accurate and complete; and
- Not make a subaward to any entity unless the entity has provided its UEI.

Subrecipients are not required to register in SAM but must obtain a UEI.

Prime Recipients and Subrecipients should commence this process as soon as possible in order to expedite the execution of a funding agreement. Registering with SAM and obtaining the UEI could take several weeks.

Prime Recipients are also required to register with the Federal Funding Accountability and Transparency Act Subaward Reporting System (FSRS) at https://www.fsrs.gov/.[36] Prime Recipients are required to report to FSRS the names and total compensation of each of the

[36] The Federal Funding Accountability and Transparency Act, P.L. 109-282, 31 U.S.C. 6101 note.

Prime Recipient's five most highly compensated executives and the names and total compensation of each Subrecipient's five most highly compensated executives. Please refer to https://www.fsrs.gov/ for guidance on reporting requirements. Prime Recipients are required to keep the FSRS data current throughout the duration of the project.

ARPA-E may not execute a funding agreement with the Prime Recipient until it has obtained a UEI and completed its SAM and FSRS registrations.

Finally, Prime Recipients are required to register with FedConnect in order to receive notification that their funding agreement has been executed by the Contracting Officer and to obtain a copy of the executed funding agreement. Please refer to https://www.fedconnect.net/FedConnect/ for registration instructions.

2. NATIONAL POLICY ASSURANCES

Project Teams, including Prime Recipients and Subrecipients, are required to comply with the National Policy Assurances attached to their funding agreement in accordance with 2 C.F.R. 200.300. Refer to Attachment 6 of ARPA-E's Model Cooperative Agreement (https://arpa-e.energy.gov/technologies/project-guidance/pre-award-guidance/funding-agreements) for information on the National Policy Assurances.

3. ENVIRONMENTAL IMPACT QUESTIONNAIRE

By law, ARPA-E is required to evaluate the potential environmental impact of projects that it is considering for funding. In particular, ARPA-E must determine before funding a project whether the project qualifies for a categorical exclusion under 10 C.F.R. § 1021.410 or whether it requires further environmental review (i.e., an environmental assessment or an environmental impact statement).

To facilitate and expedite ARPA-E's environmental review, Prime Recipients are required to complete an Environmental Impact Questionnaire during award negotiations. This form is available at https://arpa-e.energy.gov/technologies/project-guidance/pre-award-guidance/required-forms-and-templates. Each Prime Recipient must wait to complete the Environmental Impact Questionnaire (EIQ) until after ARPA-E has notified them that Attachment 3 Statement of Program Objectives is in final form. The completed EIQ is then due back to ARPA-E within 14 calendar days.

4. TECHNOLOGY-TO-MARKET PLAN

During award negotiations, Prime Recipients are required to negotiate and submit an initial Technology-to-Market Plan for Phase II and Phase IIS with the ARPA-E Program Director and obtain the ARPA-E Program Director's approval prior to the execution of the award. Prime Recipients must show how any budgeted Technology Transfer and Outreach (TT&O) costs relate

to furthering elements of the Technology-to-Market Plan. During the period of performance, Prime Recipients are required to provide regular updates on the initial Technology-to-Market plan and report on implementation of Technology-to-Market activities. Prime Recipients may be required to perform other actions to further the commercialization of their respective technologies. Prime Recipients are not required to negotiate a Technology-to-Market Plan for Phase I only awards.

ARPA-E may waive or modify this requirement, as appropriate.

5. INTELLECTUAL PROPERTY AND DATA MANAGEMENT PLANS

ARPA-E requires every Project Team to negotiate and establish an Intellectual Property Management Plan for the management and disposition of intellectual property arising from the project. The Prime Recipient must submit a completed and signed Intellectual Property Management plan to ARPA-E within six weeks of the effective date of the ARPA-E funding agreement. All Intellectual Property Management Plans are subject to the terms and conditions of the ARPA-E funding agreement and its intellectual property provisions, and applicable Federal laws, regulations, and policies, all of which take precedence over the terms of Intellectual Property Management Plans.

ARPA-E has developed a template for Intellectual Property Management Plans (https://arpa-e.energy.gov/technologies/project-guidance/post-award-guidance/project-management-reporting-requirements) to facilitate and expedite negotiations between Project Team members. ARPA-E does not mandate the use of this template. ARPA-E and DOE do not make any warranty (express or implied) or assume any liability or responsibility for the accuracy, completeness, or usefulness of the template. ARPA-E and DOE strongly encourage Project Teams to consult independent legal counsel before using the template.

Awardees are also required, post-award, to submit a Data Management Plan (DMP) that addresses how data generated in the course of the work performed under an ARPA-E award will be preserved and, as appropriate, shared publicly. At that time ARPA-E may negotiate with the Prime Recipient a mutually agreeable list of data that may be released to the public and not be treated as SBIR/STTR data. The Prime Recipient must submit a completed and signed DMP - as part of the Team's Intellectual Property Management Plan - to ARPA-E within six weeks of the effective date of the ARPA-E funding agreement.

6. U.S. COMPETITIVENESS

A primary objective of DOE's multi-billion dollar research, development and demonstration investments – including ARPA-E awards - is advancement of new energy technologies, manufacturing capabilities, and supply chains for and by U.S. industry and labor. Therefore, in exchange for receiving taxpayer dollars to support an applicant's project, the applicant must agree to the following U.S. Competitiveness Provision as part of an award under this FOA.

U.S. Competitiveness

The Contractor (Prime Recipient in ARPA-E awards) agrees that any products embodying any subject invention or produced through the use of any subject invention will be manufactured substantially in the United States unless the Contractor can show to the satisfaction of DOE that it is not commercially feasible. In the event DOE agrees to foreign manufacture, there will be a requirement that the Government's support of the technology be recognized in some appropriate manner, e.g., alternative binding commitments to provide an overall net benefit to the U.S. economy. The Contractor agrees that it will not license, assign or otherwise transfer any subject invention to any entity, at any tier, unless that entity agrees to these same requirements. Should the Contractor or other such entity receiving rights in the invention(s): (1) undergo a change in ownership amounting to a controlling interest, or (2) sell, assign, or otherwise transfer title or exclusive rights in the invention(s), then the assignment, license, or other transfer of rights in the subject invention(s) is/are suspended until approved in writing by DOE. The Contractor and any successor assignee will convey to DOE, upon written request from DOE, title to any subject invention, upon a breach of this paragraph. The Contractor will include this paragraph in all subawards/contracts, regardless of tier, for experimental, developmental or research work.

A subject invention is any invention of the contractor conceived or first actually reduced to practice in the performance of work under an award. An invention is any invention or discovery which is or may be patentable. The contractor includes any awardee, recipient, sub-awardee, or sub-recipient.

As noted in the U.S. Competitiveness Provision, at any time in which an entity cannot meet the requirements of the U.S. Competitiveness Provision, the entity may request a modification or waiver of the U.S. Competitiveness Provision. For example, the entity may propose modifying the language of the U.S. Competitiveness Provision in order to change the scope of the requirements or to provide more specifics on the application of the requirements for a particular technology. As another example, the entity may request that the U.S. Competitiveness Provision be waived in lieu of a net benefits statement or U.S. manufacturing plan. The statement or plan would contain specific and enforceable commitments that would be beneficial to the U.S. economy and competitiveness. Commitments could include manufacturing specific products in the U.S., making a specific investment in a new or existing U.S. manufacturing facility, keeping certain activities based in the U.S. or supporting a certain number of jobs in the U.S. related to the technology. If DOE, in its sole discretion, determines that the proposed modification or waiver promotes commercialization and provides substantial U.S. economic benefits, DOE may grant the request and, if granted, modify the award terms and conditions for the requesting entity accordingly.

The U.S. Competitiveness Provision is implemented by DOE pursuant to a Determination of Exceptional Circumstances (DEC) under the Bayh-Dole Act and DOE Patent Waivers.

See Section VIII.A, "Title to Subject Inventions", of this FOA for more information on the DEC and DOE Patent Waiver.

7. CORPORATE FELONY CONVICTIONS AND FEDERAL TAX LIABILITY

In submitting an application in response to this FOA, the Applicant represents that:

- It is not a corporation that has been convicted of a felony criminal violation under any Federal law within the preceding 24 months; and
- It is not a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

For purposes of these representations the following definitions apply: A Corporation includes any entity that has filed articles of incorporation in any of the 50 states, the District of Columbia, or the various territories of the United States [but not foreign corporations]. It includes both for-profit and non-profit organizations.

8. APPLICANT RISK ANALYSIS

If selected for award negotiations, ARPA-E may evaluate the risks posed by the Applicant using the criteria set forth at 2 CFR §200.206(b)(2). ARPA-E may require special award terms and conditions depending upon results of the risk analysis. As part of the research, technology, and economic security risk review, DOE may contact the applicant and/or proposed project team members for additional information to inform the review.

ARPA-E will not make an award if ARPA-E has determined that:

- The entity submitting the proposal or application:
  - has an owner or covered individual that is party to a malign foreign talent recruitment program;
  - has a business entity, parent company, or subsidiary located in the People's Republic of China or another foreign country of concern; or
  - has an owner or covered individual that has a foreign affiliation with a research institution located in the People's Republic of China or another foreign country of concern; and

- The relationships and commitments described above:
  - interfere with the capacity for activities supported by the Federal agency to be carried out;
  - create duplication with activities supported by the Federal agency;
  - present concerns about conflicts of interest;

- were not appropriately disclosed to the Federal agency;
- violate Federal law or terms and conditions of the Federal agency; or
- pose a risk to national security.

9. RECIPIENT INTEGRITY AND PERFORMANCE MATTERS

Prior to making a Federal award, ARPA-E is required to review and consider any information about Applicants that is contained in the Office of Management and Budget's designated integrity and performance system accessible through SAM (currently the Federal Awardee Performance and Integrity Information System or FAPIIS) (41 U.S.C. § 2313 and 2 C.F.R. 200.206).

Applicants may review information in FAPIIS and comment on any information about itself that a Federal awarding agency previously entered into FAPIIS.

ARPA-E will consider any written comments provided by Applicants during award negotiations, in addition to the other information in FAPIIS, in making a judgment about an Applicant's integrity, business ethics, and record of performance under Federal awards when reviewing potential risk posed by Applicants as described in 2 C.F.R. §200.205.

10. NONDISCLOSURE AND CONFIDENTIALITY AGREEMENTS REPRESENTATIONS

In submitting an application in response to this FOA the Applicant represents that:

(1) **It does not and will not** require its employees or contractors to sign internal nondisclosure or confidentiality agreements or statements prohibiting or otherwise restricting its employees or contractors from lawfully reporting waste, fraud, or abuse to a designated investigative or law enforcement representative of a Federal department or agency authorized to receive such information.

(2) **It does not and will not** use any Federal funds to implement or enforce any nondisclosure and/or confidentiality policy, form, or agreement it uses unless it contains the following provisions:

a. *"These provisions are consistent with and do not supersede, conflict with, or otherwise alter the employee obligations, rights, or liabilities created by existing statute or Executive order relating to (1) classified information, (2) communications to Congress, (3) the reporting to an Inspector General of a violation of any law, rule, or regulation, or mismanagement, a gross waste of funds, an abuse of authority, or a substantial and specific danger to public health or safety, or (4) any other whistleblower protection. The definitions, requirements, obligations, rights, sanctions, and liabilities created by controlling Executive orders and statutory provisions are incorporated into this agreement and are controlling."*

b. The limitation above shall not contravene requirements applicable to Standard Form 312, Form 4414, or any other form issued by a Federal department or agency governing the nondisclosure of classified information.

c. Notwithstanding the provision listed in paragraph (a), a nondisclosure confidentiality policy form or agreement that is to be executed by a person connected with the conduct of an intelligence or intelligence-related activity, other than an employee or officer of the United States Government, may contain provisions appropriate to the particular activity for which such document is to be used. Such form or agreement shall, at a minimum, require that the person will not disclose any classified information received in the course of such activity unless specifically authorized to do so by the United States Government. Such nondisclosure or confidentiality forms shall also make it clear that they do not bar disclosure to congress, or to an authorized official of an executive agency or the Department of Justice, that are essential to reporting a substantial violation of law.

11. INTERIM CONFLICT OF INTEREST POLICY FOR FINANCIAL ASSISTANCE

The DOE interim Conflict of Interest Policy for Financial Assistance (COI Policy) can be found at https://www.energy.gov/management/financial-assistance-letter-no-fal-2022-02. This policy is applicable to all non-Federal entities applying for, or that receive, DOE funding by means of a financial assistance award (e.g., a grant, cooperative agreement, or technology investment agreement or similar other transaction agreement) and, through the implementation of this policy by the entity, to each Investigator who is planning to participate in, or is participating in, the project funded wholly or in part under the DOE financial assistance award. DOE's interim COI Policy establishes standards that provide a reasonable expectation that the design, conduct, and reporting of projects funded wholly or in part under DOE financial assistance awards will be free from bias resulting from financial conflicts of interest or organizational conflicts of interest. The applicant is subject to the requirements of the interim COI Policy and within each application for financial assistance, the applicant must certify that it is, or will be by the time of receiving any financial assistance award, compliant with all requirements in the interim COI Policy. For applicants to any ARPA-E Funding Opportunity Announcement, this certification, disclosure of any managed or unmanaged conflicts of interest, and a copy of (or link to) the applicant's own conflict of interest policy must be included with the information provided in the Business Assurances & Disclosures Form. The applicant must also flow down the requirements of the interim COI Policy to any subrecipient non-Federal entities.

12. COMMERCIALIZATION PLAN AND SOFTWARE REPORTING

If your project is selected and it targets the development of software, you may be required to prepare a Commercialization Plan for the targeted software and agree to special provisions that require the reporting of the targeted software and its utilization. This special approach to

projects that target software mirrors the requirements for reporting that attach to new inventions made in performance of an award.

13. FRAUD, WASTE, AND ABUSE

The mission of the DOE Office of Inspector General (OIG) is to strengthen the integrity, economy, and efficiency of the Department's programs and operations, including deterring and detecting fraud, waste, abuse, and mismanagement. The OIG accomplishes this mission primarily through investigations, audits, and inspections of DOE activities to include grants, cooperative agreements, loans, and contracts.
The OIG maintains a hotline for reporting allegations of fraud, waste, abuse, or mismanagement. To report such allegations, please visit https://www.energy.gov/ig/ig-hotline.

Prime Recipients and subrecipients must disclose, in a timely manner, in writing to the Federal awarding agency or pass-through entity all violations of Federal criminal law involving fraud, bribery, or gratuity violations potentially affecting the Federal award.

Prime Recipients and subrecipients are encouraged to allocate sufficient costs in the project budget to cover the costs associated for personnel and data infrastructure needs to support performance management and program evaluation needs, including but not limited to independent program and project audits to mitigate risks for fraud, waste, and abuse.

C. REPORTING

[TO BE INSERTED BY FOA MODIFICATION IN MAY 2024]

VII. AGENCY CONTACTS

A. COMMUNICATIONS WITH ARPA-E

Upon the issuance of a FOA, only the Contracting Officer may communicate with Applicants. ARPA-E personnel and our support contractors are prohibited from communicating (in writing or otherwise) with Applicants regarding the FOA. This "quiet period" remains in effect until ARPA-E's public announcement of its project selections.

During the "quiet period," Applicants are required to submit all questions regarding this FOA to ARPA-E-CO@hq.doe.gov. Questions and Answers (Q&As) about ARPA-E and the FOA are available at http://arpa-e.energy.gov/faq. For questions that have not already been answered, please send an email with the FOA name and number in the subject line to ARPA-E-CO@hq.doe.gov. Due to the volume of questions received, ARPA-E will only answer pertinent questions that have not yet been answered and posted at the above link.

- ARPA-E will post responses on a weekly basis to any questions that are received that have not already been addressed at the link above. ARPA-E may re-phrase questions or consolidate similar questions for administrative purposes.
- ARPA-E will cease to accept questions approximately 10 business days in advance of each submission deadline. Responses to questions received before the cutoff will be posted no later than three business days in advance of the submission deadline. ARPA-E may re-phrase questions or consolidate similar questions for administrative purposes.
- Responses are published in a document specific to this FOA under "CURRENT FUNDING OPPORTUNITIES – FAQS" on ARPA-E's website (http://arpa-e.energy.gov/faq).

Applicants may submit questions regarding ARPA-E eXCHANGE, ARPA-E's online application portal, to ExchangeHelp@hq.doe.gov. ARPA-E will promptly respond to emails that raise legitimate, technical issues with ARPA-E eXCHANGE. ARPA-E will refer any questions regarding the FOA to ARPA-E-CO@hq.doe.gov.

ARPA-E will not accept or respond to communications received by other means (e.g., fax, telephone, mail, hand delivery). Emails sent to other email addresses will be disregarded.

During the "quiet period," only the Contracting Officer may authorize communications between ARPA-E personnel and Applicants. The Contracting Officer may communicate with Applicants as necessary and appropriate. As described in Section IV.A of the FOA, the Contracting Officer may arrange pre-selection meetings and/or site visits during the "quiet period."

B. DEBRIEFINGS

ARPA-E does not offer or provide debriefings. ARPA-E provides Applicants with a notification encouraging or discouraging the submission of a Full Application based on ARPA-E's assessment of the Concept Paper. In addition, ARPA-E provides Applicants with reviewer comments on Full Applications before the submission deadline for Replies to Reviewer Comments.

VIII. OTHER INFORMATION

A. TITLE TO SUBJECT INVENTIONS

Ownership of subject inventions is governed pursuant to the authorities listed below:

- Domestic Small Businesses, Educational Institutions, and Nonprofits: Under the Bayh-Dole Act (35 U.S.C. § 200 et seq.), domestic small businesses, educational institutions, and nonprofits may elect to retain title to their subject inventions;
- All other parties: The federal Non-Nuclear Energy Act of 1974, 42. U.S.C. 5908, provides that the government obtains title to new subject inventions unless a waiver is granted (see below):
  - Class Patent Waiver for Domestic Large Businesses: DOE has issued a class patent waiver that applies to this FOA. Under this class patent waiver, domestic large businesses may elect title to their subject inventions similar to the right provided to the domestic small businesses, educational institutions, and nonprofits by law. In order to avail itself of the class patent waiver, a domestic large business must agree to the U.S. Competitiveness Provision in accordance with Section VI.B.6. of this FOA.
  - Advance and Identified Waivers: For applicants that do not fall under the class patent waiver or the Bayh-Dole Act, those applicants may request a patent waiver that will cover subject inventions that may be made under the award, in advance of or within 30 days after the effective date of the award. Even if an advance waiver is not requested or the request is denied, the recipient will have a continuing right under the award to request a waiver for identified inventions, i.e., individual subject inventions that are disclosed to DOE within the time frames set forth in the award's intellectual property terms and conditions. Any patent waiver that may be granted is subject to certain terms and conditions in 10 CFR 784.
- DEC: On June 07, 2021, DOE approved a DETERMINATION OF EXCEPTIONAL CIRCUMSTANCES (DEC) UNDER THE BAYH-DOLE ACT TO FURTHER PROMOTE DOMESTIC MANUFACTURE OF DOE SCIENCE AND ENERGY TECHNOLOGIES. In accordance with this DEC, all awards, including sub-awards, under this FOA made to a Bayh-Dole entity (domestic small businesses and nonprofit organizations) shall include the U.S. Competitiveness Provision in accordance with Section VI.B.6 of this FOA. A copy of the DEC may be found on the DoE website. Pursuant to 37 CFR § 401.4, any Bayh-Dole entity affected by this DEC has the right to appeal it by providing written notice to DOE within 30 working days from the time it receives a copy of the determination.

B. GOVERNMENT RIGHTS IN SUBJECT INVENTIONS

Where Prime Recipients and Subrecipients retain title to subject inventions, the U.S. Government retains certain rights.

1. GOVERNMENT USE LICENSE

The U.S. Government retains a nonexclusive, nontransferable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States any subject invention throughout the world. This license extends to contractors doing work on behalf of the Government.

2. MARCH-IN RIGHTS

The U.S. Government retains march-in rights with respect to all subject inventions. Through "march-in rights," the Government may require a Prime Recipient or Subrecipient who has elected to retain title to a subject invention (or their assignees or exclusive licensees), to grant a license for use of the invention. In addition, the Government may grant licenses for use of the subject invention when Prime Recipients, Subrecipients, or their assignees and exclusive licensees refuse to do so.

The U.S. Government may exercise its march-in rights if it determines that such action is necessary under any of the four following conditions:

- The owner or licensee has not taken or is not expected to take effective steps to achieve practical application of the invention within a reasonable time;
- The owner or licensee has not taken action to alleviate health or safety needs in a reasonably satisfactory manner;
- The owner has not met public use requirements specified by Federal statutes in a reasonably satisfactory manner; or
- The U.S. Manufacturing requirement has not been met.

C. RIGHTS IN TECHNICAL DATA

Data rights differ based on whether data is first produced under an award or instead was developed at private expense outside the award.

- Background or "Limited Rights Data": The U.S. Government will not normally require delivery of technical data developed solely at private expense prior to issuance of an award, except as necessary to monitor technical progress and evaluate the potential of proposed technologies to reach specific technical and cost metrics.
- Generated Data: Pursuant to special statutory authority for SBIR/STTR awards, data generated under ARPA-E SBIR/STTR awards may be protected from public disclosure for twenty years from the date of award in accordance with provisions that will be set forth in the award. In addition, invention disclosures may be protected from public disclosure for a reasonable time in order to allow for filing a patent application.

D. PROTECTED PERSONALLY IDENTIFIABLE INFORMATION

Applicants may not include any Protected Personally Identifiable Information (Protected PII) in their submissions to ARPA-E. Protected PII is defined as data that, if compromised, could cause harm to an individual such as identity theft. Listed below are examples of Protected PII that Applicants must not include in their submissions.

- Social Security Numbers in any form;
- Place of Birth associated with an individual;
- Date of Birth associated with an individual;
- Mother's maiden name associated with an individual;
- Biometric record associated with an individual;
- Fingerprint;
- Iris scan;
- DNA;
- Medical history information associated with an individual;
- Medical conditions, including history of disease;
- Metric information, e.g., weight, height, blood pressure;
- Criminal history associated with an individual;
- Ratings;
- Disciplinary actions;
- Performance elements and standards (or work expectations) are PII when they are so intertwined with performance appraisals that their disclosure would reveal an individual's performance appraisal;
- Financial information associated with an individual;
- Credit card numbers;
- Bank account numbers; and
- Security clearance history or related information (not including actual clearances held).

E. FOAS AND FOA MODIFICATIONS

FOAs are posted on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/), Grants.gov (http://www.grants.gov/), and FedConnect (https://www.fedconnect.net/FedConnect/). Any modifications to the FOA are also posted to these websites. You can receive an e-mail when a modification is posted by registering with FedConnect as an interested party for this FOA. It is recommended that you register as soon as possible after release of the FOA to ensure that you receive timely notice of any modifications or other announcements. More information is available at https://www.fedconnect.net.

F. OBLIGATION OF PUBLIC FUNDS

The Contracting Officer is the only individual who can make awards on behalf of ARPA-E or

obligate ARPA-E to the expenditure of public funds. A commitment or obligation by any individual other than the Contracting Officer, either explicit or implied, is invalid.

ARPA-E awards may not be transferred, assigned, or assumed without the prior written consent of a Contracting Officer.

G. REQUIREMENT FOR FULL AND COMPLETE DISCLOSURE

Applicants are required to make a full and complete disclosure of the information requested in the Business Assurances & Disclosures Form. Disclosure of the requested information is mandatory. Any failure to make a full and complete disclosure of the requested information may result in:

- The rejection of a Concept Paper, Full Application, and/or Reply to Reviewer Comments;
- The termination of award negotiations;
- The modification, suspension, and/or termination of a funding agreement;
- The initiation of debarment proceedings, debarment, and/or a declaration of ineligibility for receipt of Federal contracts, subcontracts, and financial assistance and benefits; and
- Civil and/or criminal penalties.

H. RETENTION OF SUBMISSIONS

ARPA-E expects to retain copies of all Concept Papers, Full Applications, Replies to Reviewer Comments, and other submissions. No submissions will be returned. By applying to ARPA-E for funding, Applicants consent to ARPA-E's retention of their submissions.

I. MARKING OF CONFIDENTIAL INFORMATION

ARPA-E will use data and other information contained in Concept Papers, Full Applications, and Replies to Reviewer Comments strictly for evaluation purposes.

Concept Papers, Full Applications, Replies to Reviewer Comments, and other submissions containing confidential, proprietary, or privileged information should be marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Government is not liable for the disclosure or use of unmarked information and may use or disclose such information for any purpose.

The cover sheet of the Concept Paper, Full Application, Reply to Reviewer Comments, or other submission must be marked as follows and identify the specific pages containing confidential, proprietary, or privileged information:

Notice of Restriction on Disclosure and Use of Data:

Pages [___] of this document may contain confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes or in accordance with a financial assistance or loan agreement between the submitter and the Government. The Government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source.
The header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: "Contains Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure." In addition, every line and paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets or highlighting.

J. EXPORT CONTROL INFORMATION

Do not include information subject to export controls in any submissions, including Concept Papers, Full Applications, and Replies to Reviewer Comments – whether marked as subject to US export control laws/regulations or otherwise. Such information may not be accepted by ARPA-E and may result in a determination that the application is non-compliant, and therefore not eligible for selection. This prohibition includes any submission containing a general, non-determinative statement such as "The information on this page [or pages _ to__] may be subject to US export control laws/regulations", or similar. Under the terms of their award, awardees shall be responsible for compliance with all export control laws/regulations.

K. COMPLIANCE AUDIT REQUIREMENT

A prime recipient organized as a for-profit entity expending $750,000 or more of DOE funds in the entity's fiscal year (including funds expended as a Subrecipient) must have an annual compliance audit performed at the completion of its fiscal year. For additional information, refer to Subpart F of: (i) 2 C.F.R. Part 200, and (ii) 2 C.F.R. Part 910.

If an educational institution, non-profit organization, or state/local government is either a Prime Recipient or a Subrecipient and has expended $750,000 or more of Federal funds in the entity's fiscal year, the entity must have an annual compliance audit performed at the completion of its fiscal year. For additional information refer to Subpart F of 2 C.F.R. Part 200.

L. PAYMENT OF FEE OR PROFIT

ARPA-E will pay a fee or profit to Prime Recipients in an amount not to exceed 7% of total project cost under any agreement resulting from this FOA, subject to negotiations. Any fee or profit paid by Prime Recipients to their sub-recipients (but not commercial suppliers, vendors, or contractors) must be paid from fee or profit paid to Prime Recipients by ARPA-E. Any fee or profit must be included in the budget submitted with Prime Recipients' Full Applications and

will be payable to Prime Recipients upon: (i) completion of all work required by the agreement, (ii) submission and acceptance of all for-profit audit reports and resolution of all findings (if any) identified in the reports, (iii) submission and acceptance by the Government of all closeout documentation required by Attachment 4 to the agreement (refer to ARPA-E's Model Cooperative Agreement found at https://arpa-e.energy.gov/?q=site-page/funding-agreements), and (iv) submission of an acceptable invoice.

M. ADDITIONAL NOTICES

- This FOA is intended for informational purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR or STTR funding agreement, the terms of the funding agreement are controlling.
- Before award of an SBIR or STTR funding agreement, ARPA-E may request the selectee to submit certain organizational, management, personnel, and financial information to assure responsibility of the Prime Recipient. In addition, selectees will be required to make certain legal commitments at the time of execution of funding agreements resulting from this FOA. ARPA-E encourages Prime Recipients to review the Model Cooperative Agreement for SBIR/STTR Awards, which is available at https://arpa-e.energy.gov/?q=site-page/funding-agreements.
- Actual or suspected fraud, waste, or abuse may be reported to the DOE Office of Inspector General (OIG) at 1-800-541-1625.

IX. GLOSSARY

Applicant: The entity that submits the application to ARPA-E. In the case of a Project Team, the Applicant is the lead organization listed on the application.

Application: The entire submission received by ARPA-E, including the Preliminary Application, Full Application, Reply to Reviewer Comments, and Small Business Grant Application (if applicable).

ARPA-E: is the Advanced Research Projects Agency – Energy, an agency of the U.S. Department of Energy.

Cost Sharing: Is the portion of project costs from non-Federal sources that are borne by the Prime Recipient (or non-Federal third parties on behalf of the Prime Recipient), rather than by the Federal Government.

Covered Individual: an individual who contributes in a substantive, meaningful way to the scientific development or execution of an R&D project proposed to be carried out with an award from ARPA-E. This includes, but is not limited to, the PI, Co-PI, Key Personnel, and technical staff (e.g., postdoctoral fellows/researchers and graduate students). ARPA-E may further designate covered individuals during award negotiations or the award period of performance.

Deliverable: A deliverable is the quantifiable goods or services that will be provided upon the successful completion of a project task or sub-task.

DOE: U.S. Department of Energy.

DOE/NNSA: U.S. Department of Energy/National Nuclear Security Administration.

FFRDCs: Federally Funded Research and Development Centers.

FOA: Funding Opportunity Announcement.

Foreign Affiliation: a funded or unfunded academic, professional, or institutional appointment or position with a foreign government or government-owned entity, whether full-time, part-time, or voluntary (including adjunct, visiting, or honorary).

Foreign Countries of Concern: the People's Republic of China, the Democratic People's Republic of Korea, the Russian Federation, the Islamic Republic of Iran, Burma, Eritrea, Pakistan, Saudi Arabia, Tajikistan, and Turkmenistan.

For-Profit Organizations (or For-Profit Entities): Entities organized for-profit (including Large Businesses or Small Businesses).

GOCOs: U.S. Government Owned, Contractor Operated laboratories.

GOGOs: U.S. Government Owned, Government Operated laboratories.

Malign Foreign Talent Recruitment Program: the meaning given such term in section 10638 of the Research and Development, Competition, and Innovation Act (division B of Public Law 117–167) or 42 USC 19237, as of October 20, 2022.

Milestone: A milestone is the tangible, observable measurement that will be provided upon the successful completion of a project task or sub-task.

Nonprofit Organizations (or *nonprofits*): Has the meaning set forth at 2 C.F.R. § 200.70.

Prime Recipient: The signatory to the funding agreement with ARPA-E.

PI: Principal Investigator.

Project Team: A Project Team consists of the Prime Recipient, Subrecipients, and others performing or otherwise supporting work under an ARPA-E funding agreement.

SBA: U.S. Small Business Administration.

SBIR: Small Business Innovation Research Program.

Small Business: Small businesses are domestically incorporated entities that meet the criteria established by the U.S. Small Business Administration's (SBA) "Table of Small Business Size Standards Matched to North American Industry Classification System Codes" (NAICS) (http://www.sba.gov/content/small-business-size-standards).

Small Business Concern: A for-profit entity that: (1) maintains a place of business located in the United States; (2) operates primarily within the United States or makes a significant contribution to the United States economy through payment of taxes or use of American products, materials or labor; (3) is an individual proprietorship, partnership, corporation, limited liability company, joint venture, association, trust, or cooperative; and (4) meets the size eligibility requirements set forth in 13 C.F.R. § 121.702. Where the entity is formed as a joint venture, there can be no more than 49% participation by foreign business entities in the joint venture. Such joint ventures must submit the VCOC/FJV Certification (the seventh component of the Full Application).

Standalone Applicant: An Applicant that applies for funding on its own, not as part of a Project Team.

STTR: Small Business Technology Transfer Program.

Subject Invention: Any invention conceived or first actually reduced to practice under an ARPA-E funding agreement.

Subrecipient: An entity (not an individual) that receives a subaward from the Prime Recipient to carry out part of the ARPA-E award.

Task: A task is an operation or segment of the work plan that requires both effort and resources. Each task (or sub-task) is connected to the overall objective of the project, via the achievement of a milestone or a deliverable.

Total Project Cost: The sum of the Prime Recipient share and the Federal Government share of total allowable costs. The Federal Government share generally includes costs incurred by GOGOs, FFRDCs, and GOCOs.

TT&O: Technology Transfer and Outreach. (See Section IV.G.8 of the FOA for more information).